AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

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Electric Driving of Tools in the Baldwin Locomotive Works, Philadelphia.

Three years ago, in 1892, we first began to notice the appearance of the electric motor as a machine shop drive, applied in some cases to machine tools individually, and in other cases to individual sections of line shafting in machine shops.

As a matter of course the older steam engineers smiled at the idea; it was really amusing to hear these electrical fellows talk. Did not the steam engine have to turn the dynamo to make the current to turn the little electrical engine which drove the individual machine tool, or the section of machine shop line shaft? Then why this House-That-Jack-Built multiplication of needless elements between the grate bars and the final effect? Was it not enough to have to introduce a costly and delicate steam engine without the absurd interposition of a lot of electric current generating and electric current using elements between the engine fly wheel and the finally driven machine? So the gray mustachios lifted at the ends, and the eager young electricians bustled about in their ways, and the steam engineers waited calmly for the electrical fellows to tumble over themselves and never get up again. The tumble has come. Unhappily for the graybeards, it was not the young men with the dynamos who fell down. With the aid of the electrical current the youths can take the very commonest slide valve engine ever designed and make the coal pile stay with them a good deal longer than the high efficiency steam engineer can keep it, and use leather belts for the same work.

The Baldwin locomotive shops located possibly at 15th and Buttonwood streets, Philadelphia, as those placid thoroughfares pass through the works, have put, in round figures, 250 horse-power of Westinghouse engines in place of 500 horse-power of a much more expensive type of steam motor, to do exactly the same amount of machine driving. The Westinghouse engines drive dynamos, and the dynamo current is wired to the independent motors on the tools shown in the engravings. The steam engine which formerly drove the Baldwin shops exerted itself mainly in bending big belts around pulleys, and turning shafts which labored in their effort to resist the strain of these big belts. The actual effort used in cutting the wire chips, which was the ultimate object of all the overhead maze of line shafting, and countershafting, and pulleys and belts in the Baldwin shops, was perhaps not 10 per cent. of the power delivered by the engine. At all events, half the formerly needed cylinder diameter is now ample to run these great shops, which are the largest of their kind in the world, and employ 5,500 men when running full. Hence the Baldwin experiment cannot be held as in any way of limited significance. It must be accepted as a broad, general fact, amply sufficient for the stable basing of future practice.

And it is well to say here that there is no iconoclastic basis to the engineering direction of the Baldwin shops. There is no following after strange gods, no vainglorious desire to be first in the field, no wish to show the rest of the machine-shop world the right way to do things.

The Baldwin shops have discovered, through years of experience, that heavy pieces are more cheaply handled by cranes than by unaided muscle; such a crane as they wished to place above their wheel lathe floor could not be put in place if the wheel lathes and boring mills were to be driven by belts and countershafts in the usual machine-shop manner. The crane must go in, therefore the belt drive must go out, since the two could not be used together. There is still plenty of line shaft and plenty of belting, and a very great many countershafts in use in the Baldwin locomotive shops, and some of these things may linger there for long years yet; it all depends on the price of little motors—

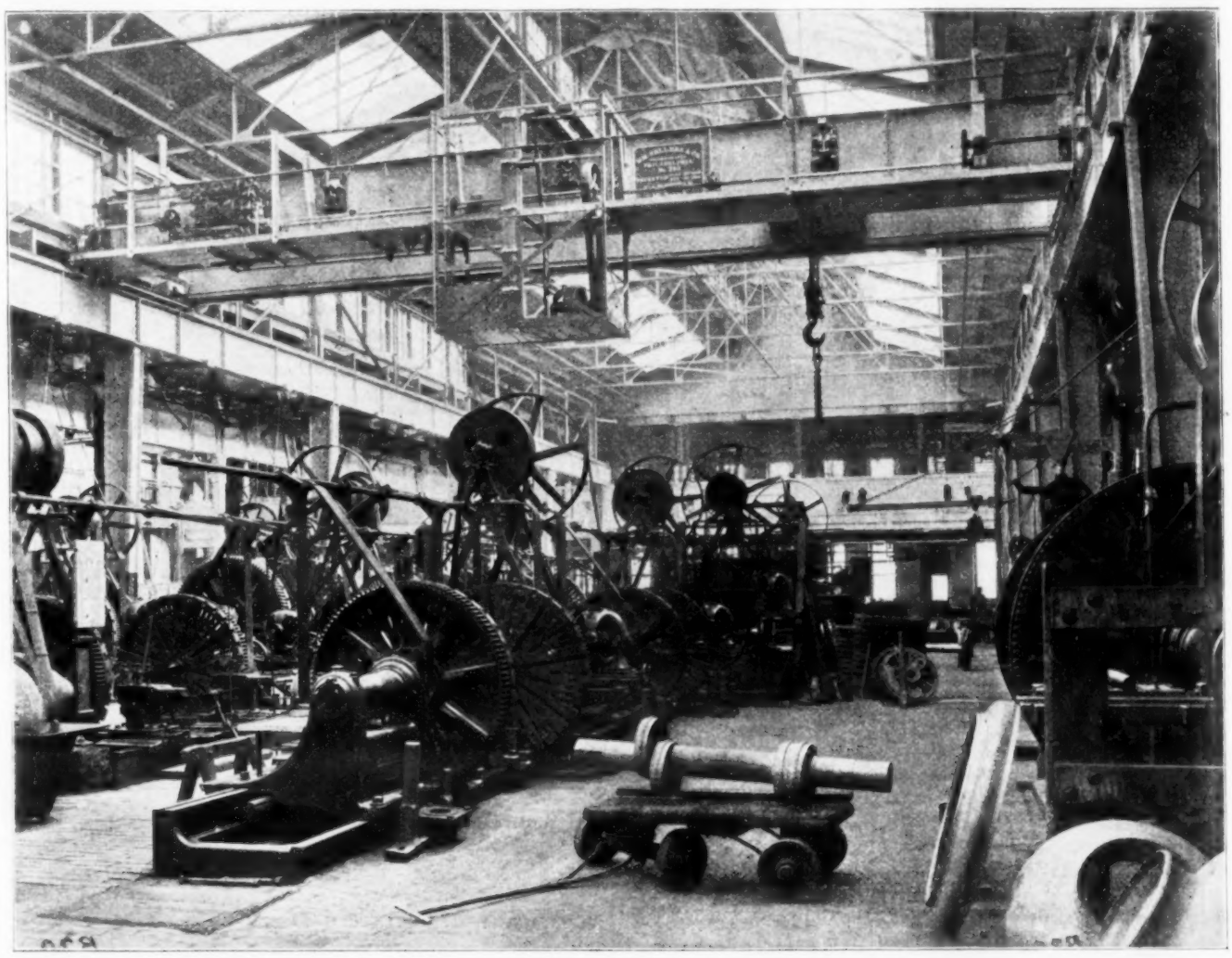


Fig. 1.

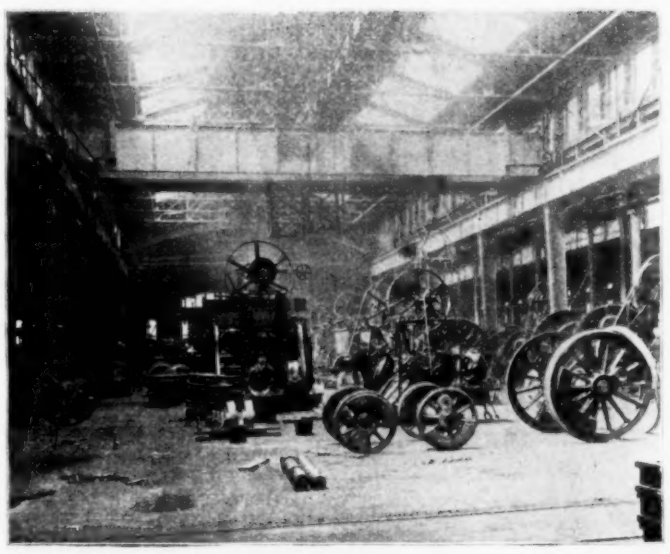


Fig. 2.

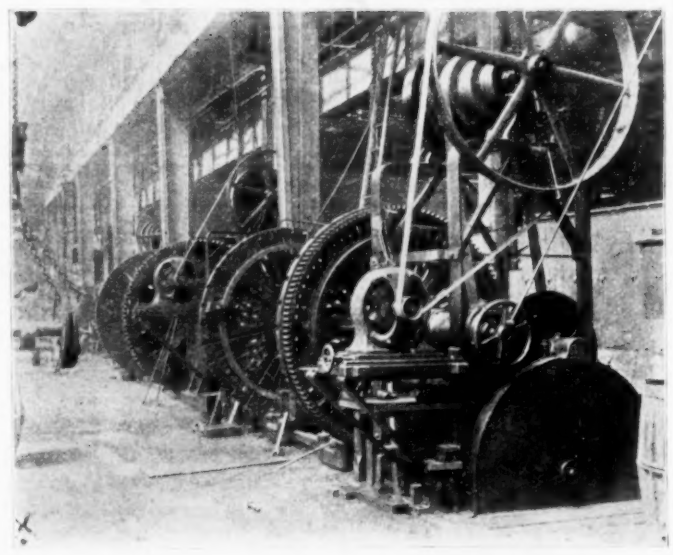


Fig. 3.

ELECTRIC DRIVING OF TOOLS IN THE BALDWIN LOCOMOTIVE SHOPS.

nothing else. It is easier for the workman to move a little bright brass lever, with a nice, clean, little hard rubber knob at its end, than it is to give a vigorous tug at a greasy wooden shipper handle reaching upward in the gloomy wilderness of countershafts and line belting overhead in the ordinary shop.

It is easier for the workman to see by daylight than by candles and lamps, as he must if all the light which can be given the shop from overhead is absorbed by black belting and shafting.

But it was solely, as before stated, because a crane can pick up and carry a 5 or 10-ton piece quicker and cheaper than men alone can do it, that the Baldwin shops put an electric drive into their wheel lathe room.

The little brass lever, with the clean black rubber handle, and the daylight came in as incidents, not as ends sought.

The engravings show the caves of gloom on either side of the wheel lathes. There are spaces in which the line and countershafts and the leather belt drive still reign supreme. The cheerful open-day aspect of the wheel lathe floor is by no means universal in the Baldwin shops as yet.

But daylight must finally become the rule in machine shops. The line shaft and the countershaft may linger long, and the leather belt may continue to absorb machine oil, to get slack, to demand new lacing, to load grinding countershafts and squeaking loose pulleys, but the day of leather-belt driving has gone, and the day of daylight in the machine shop is surely dawning.

The engravings given here are so full, and so thoroughly display the simple details incident to the use of the electric drive, that little description need be given. The pictures tell the story.

Fig. 1 is a general view of the Baldwin wheel lathe room, with a 10-ton, traveling, electric, Sellers crane overhead. This view shows the delightfully clear and cheerful appearance of the room no less strikingly than does the smaller, more general view given in Fig. 2, which is a complete view, looking to the west, taken in the noon hour, with everything still. While it is true that the double skylight of this wheel lathe room gives it a great advantage, it is none the less true that the darkness of the rooms at the right and left is largely due to the wilderness of overhead shafting and pulleys and belts which do not appear in the wheel room, because the electric motor drive has taken its place. Before the electrive drive was put in the wheel room was, as I am informed, very dark indeed.

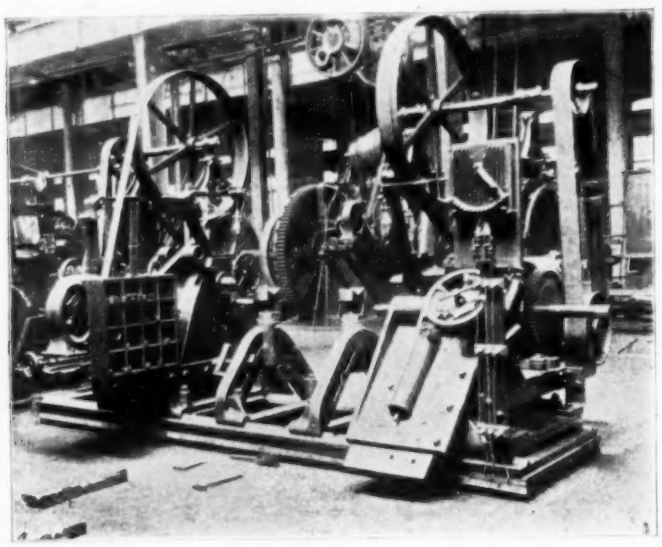


Fig. 4

Fig. 3 is a view of part of the bank of wheel lathes on the north side of the Baldwin wheel room, looking west. This view shows very clearly the wrought-iron countershaft and motor frame applied to these lathes, and the belt between the small pulley on the high-speed motor shaft and the large countershaft driving pulley overhead which drives the upper cone shaft. The wooden motor base is bolted to two wrought-iron brackets, in turn bolted to the left-hand face of the uprights of the wrought-iron counter-shaft frames.

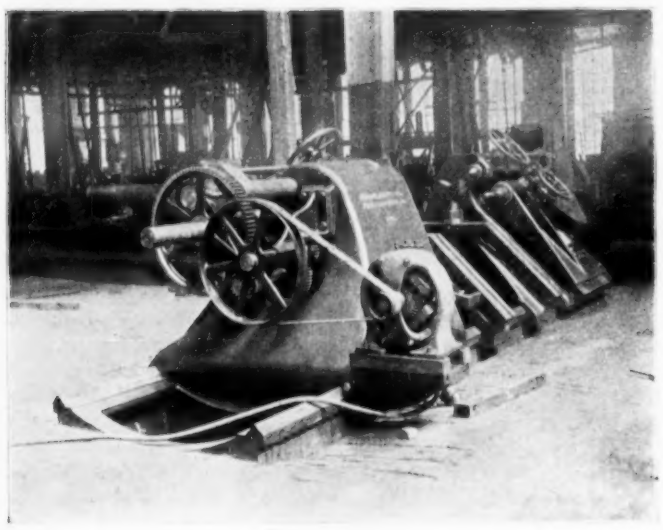


Fig. 5.

Fig. 4 shows very clearly the electric drive as applied to a small quartering machine.

Fig. 5 shows the electric drive as applied to the heaviest of the Baldwin quartering machines. This is a massive tool, the bed alone weighing 35 tons; the design affords a model of elegant simplicity, and with its neat and excellent arrangement of the electric drive this beautiful machine may be justly said to represent the latest and best practice in locomotive tool building, and I deeply regret that space does not permit the insertion here of such engravings as would fully represent its general appearance and construction. This quartering machine was built by Bement, Miles & Co., and I think no one who sees it will deny that its place is among the masterpieces of the tool builder's art.

Fig. 6 shows the wrought-iron countershaft frame and electric drive as applied to a boring mill; the engraving is so complete as to demand no special description. The darkness of the distances is particularly notable, although the high side windows have an additional light above each.

The temptation is strong to multiply examples of the Baldwin electric driving, because its success is so great in the way of convenience and added light, and the economy in driving power is so marked, but space compels me to rest with the views already given. I may add, however, that there is a decided gain in output due to the perfect readiness of the motor to operate at all times, and to the more delicately suitable speeds which can be had through independent motor driving. The men in the Baldwin shops work almost exclusively on piece prices, and their strong preference for the independent electric drive can only be explained on the ground of increased product with the same labor. Part of this increase is undoubtedly due to increased light, but the increased light cannot be had while the overhead belt and countershaft drive is used, so that all the increase of output is justly credited to the electric drive.

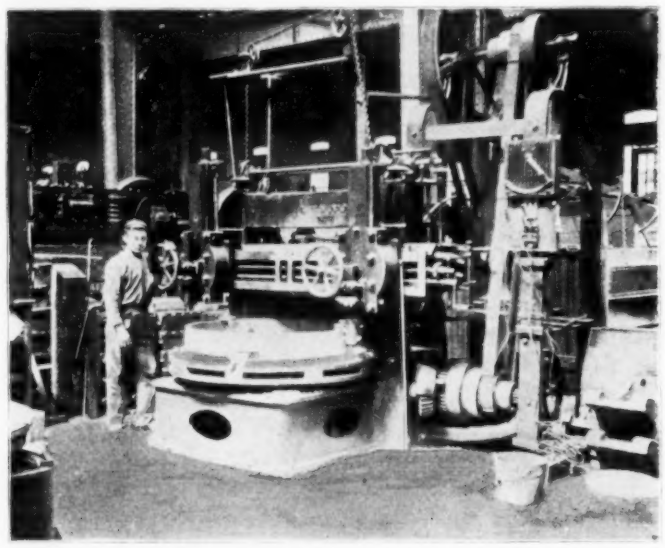


Fig. 6.

Fig. 7 shows the pulley side of the Gibbs multipolar motor, standard "M" type, used exclusively by the Baldwin shops for tool driving, built by the Gibbs Electric Co., Milwaukee, Wis. Fig. 8 shows the frame construction of the "M" type of Gibbs motor. I hope soon to give an illustration of the heavier "F" type driving a roll train in one of the largest American steel plants.

The bearings of the "M" type are self-adjusting (ball and socket) and self-oiling with a sight-feed oil gage. The frame consists of two pieces only, rabbeted and bolted beyond the possibility of accidental shifting of the frame parts. There are also valuable novelties introduced in the brush holders and in the brush and brush holder proper connections, which insure cool running and durability. Up to 9 K. W. the brushes are fixed and need no adjustment, the design being so near perfection that no sparking occurs with any change of load. All connections, cables and wires are held in fixed positions, thus avoiding what is often a source of annoyance and danger. The armature is of such design and so perfectly provided with radiating surfaces that in no case does the temperature of these motors rise more than 86° Fahr. above the atmosphere, and the best insulating material is so freely used as to enable the armatures to endure a final test with alternating current of 1,500 volts potential for crosses and grounds, an unusually severe test for low potential apparatus. The Gibbs type "M" motors vary in speed from 1,150 revolutions per minute for the 400-pound, 2 K. W., 2 horse-power motor, to 950 revolutions for the 1,540-pound, 9 K. W., 10 horse-power motor, there being three sizes of 3, 4, and 6½ horse-power between these two extremes.

I inspected the Gibbs shops at Milwaukee and found an equipment of excellent tools operated under a high standard system of close inspection, which probably accounts in part, at least, for the excellent results given by the Gibbs motors in use at the Baldwin shops. The design of the motors is simple and substantial, and presumably electrically correct; I am not competent to pass an opinion on this last point; I do know, however, that the machine work on this "M" type of machine is really exceptionally good.

From this extensive example of electric machine tool driving with all its advantages of low power cost, increased efficiency, improved lighting, and acceptability to workmen, the discriminating machine shop superintendent can draw but one conclusion.

The heavy line shaft and countershaft and the heavy leather belt are costly coal eaters and light absorbers; their room is very largely to be preferred to their company, and the sooner they go the better for all concerned.

Half the coal saved, the change of light from evening shades to noonday brightness, the abolition of the ladder and the overhead

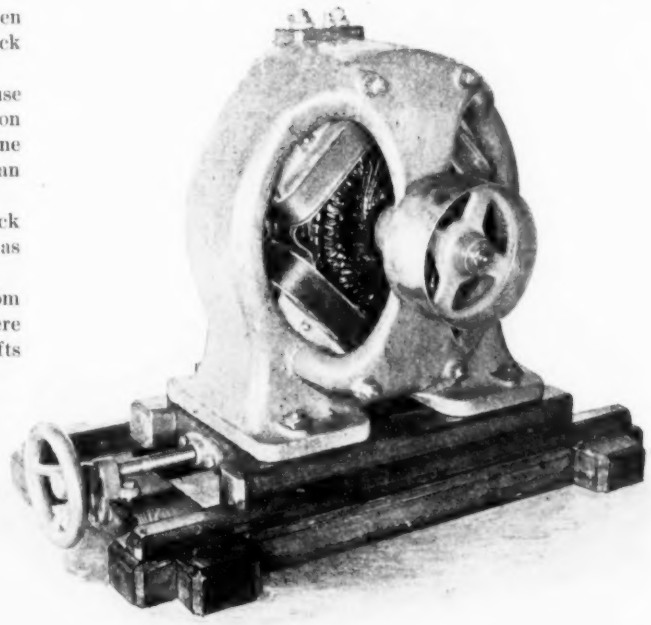


Fig. 7.

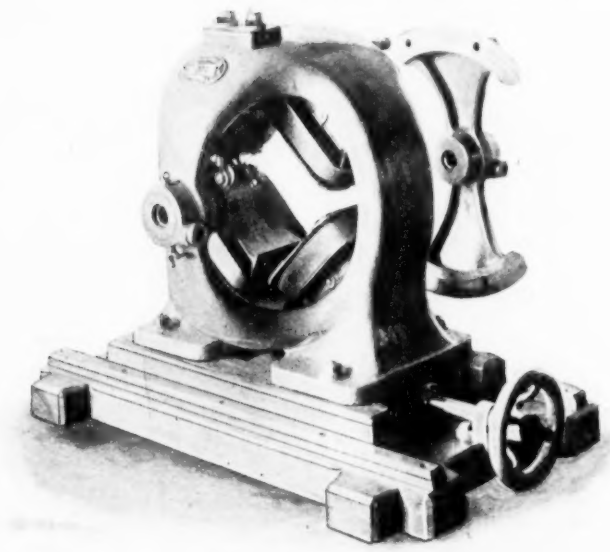


Fig. 8.

ELECTRIC DRIVING OF TOOLS IN THE BALDWIN LOCOMOTIVE SHOPS.

oiler and overhead belt lacer, all of these are ends of value to be gained. The Baldwin shops have shown the way clearly enough; electric driving is not an experiment; it is a large scale solid economical fact, and the superintendent who neglects this example must be indeed a follower of the old school.

PATRICK DROLAN.

Officers Western Foundrymen's Association.

At a recent meeting of the Western Foundrymen's Association, the following officers were elected for the ensuing year:

President, John M. Sweeney, of the Chicago Consolidated Iron and Steel Co., Harvey, Ill.

Vice-president, A. W. McArthur, Rockford Foundry Co., Rockford, Ill.

Treasurer, O. T. Stantial, Illinois Malleable Iron Co., Chicago, Ill.

Secretary, S T. Johnston, Whiting Foundry Equipment Co., Chicago, Ill.

EXECUTIVE COMMITTEE.

B. M. Gardner, *Iron Trade Review*.

C. A. Sercomb, Schwab & Sercomb, Milwaukee, Wis.

James Frake, Chicago, Ill.

Geo. M. Sargent, The Sargent Co., Chicago, Ill.

W. N. Moore, Joliet Stove Works, Joliet, Ill.

Screw Machine.

We present an illustration of a screw machine, which though it conforms to what has come to be regarded as the standard type, has some special points of interest, and is certainly very neat and substantial in appearance.

Special facilities have been provided for maintaining proper alignment, by moving the head stock, bodily, either vertically or laterally; the fact being recognized that accurate maintenance of alig ment is of prime importance in the satisfactory working of screw machines.

The spindle is of forged crucible steel with ground bearings, and runs in phosphor-bronze bearings. The front box is in halves, and is firmly seated in the head stock, and supported by it to its extreme ends, the thrust is taken by a hardened and ground collar on front end of front box, and wear is taken up at the rear of same box.

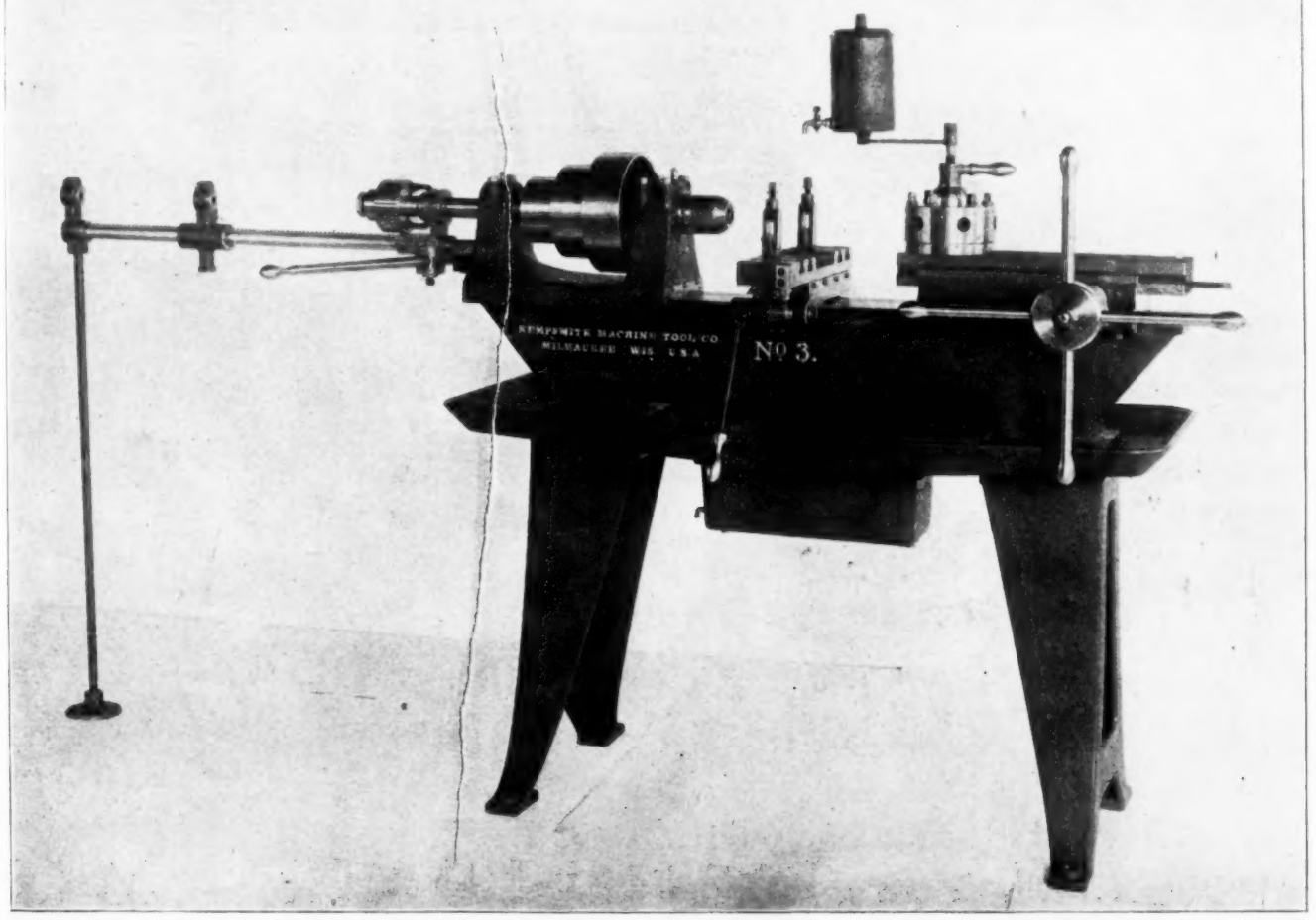
Passing through the spindle is a $1\frac{5}{16}$-inch hole; the hole in the chuck closing tube being $\frac{13}{16}$ inch diameter—to admit $\frac{3}{4}$ inch stock.

The cone is for a $2\frac{1}{2}$ inch belt, and the largest step is 9 inches. The wire feed is the well-known Parkhurst, which feeds the stock and opens and closes the chuck by the movement of a single lever and without stopping the machine.

The turret revolves automatically on hardened and ground steel center bearing, and the locking mechanism is constructed throughout of hardened tool steel.

The cut-off slide is operated by rack and pinion, and the tool posts are provided with a parallel and rigid adjustment by means of taper wedges.

There is a double-friction countershaft, and the machine is furnished with a lever on the turret slide, instead of the turn stile, if preferred. It swings over the bed $12\frac{1}{4}$ inches; has a turret $6\frac{1}{4}$ inches diameter, with six 1-inch holes. The length of cut that can be taken is $5\frac{1}{2}$ inches, and the greatest working distance from turret to spindle is 20 inches. The bed is 52 inches long, and the machine weighs about 1,200 pounds. It is built by the Kempsmith Machine Tool Co., Milwaukee, Wis.

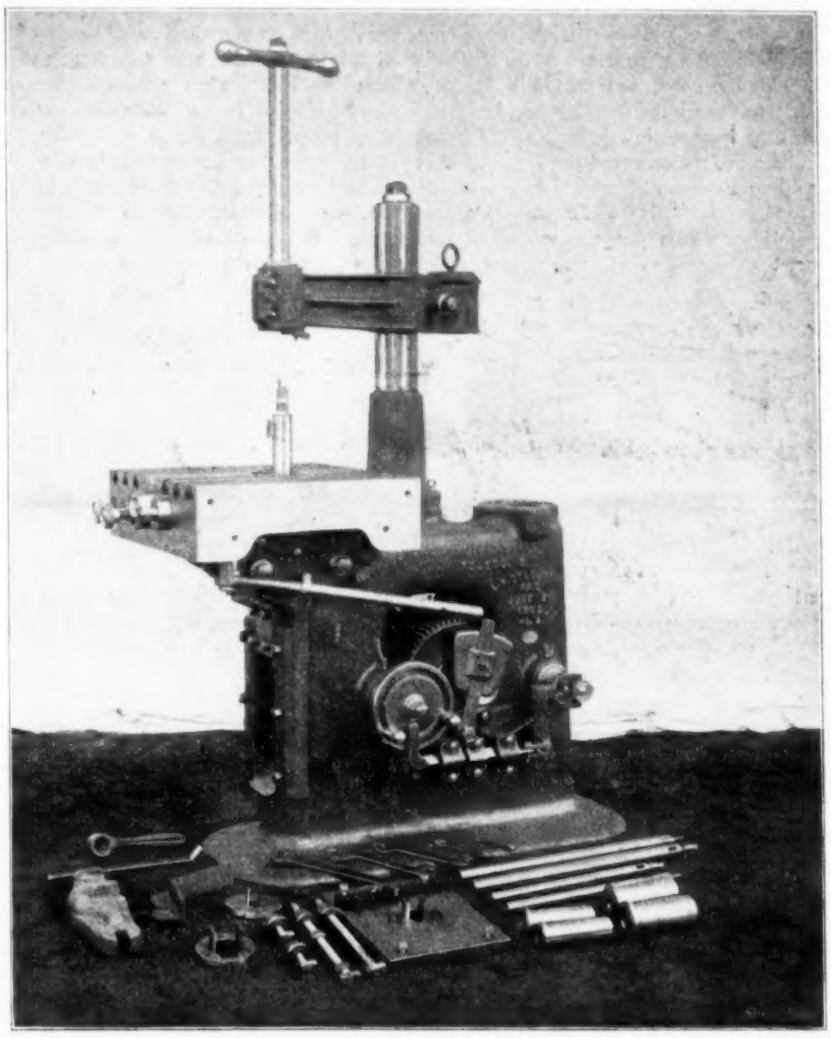


SCREW MACHINE.

Improved Keyway Cutter.

We illustrate herewith an improved keyway cutter, built by Baker Brothers, of Toledo, Ohio. This size machine is known as the No. 2, and will cut keyways up to 16 inches long by 2 inches wide. It is the same machine as illustrated in our issue of July 6, 1893, but since that time has been greatly improved.

Among the changes made may be mentioned the extension of the quadrants in such a manner that a support is given the table both in front and in the rear, thus effectually preventing all spring in same, and conducing to accuracy of work. The table is adapted to tilt in either direction, and the amount of taper per foot is always shown by a pointer on the graduated scale at the side of machine. For regulating the depth of keyseat screw gages are attached to the front of table. One gage regulates the depth of cut taken at each stroke of the cutter bar, another is set to gage the total depth of keyway. This has a dial plate graduated in both sixty-fourths and thousandths, enabling a very fine adjustment to be made, and insuring duplication. A third gage is provided for regulating depth of cut when the cutter is used on the back of the bar, as it is, sometimes, for special work. Quite a variety of internal slotting can be done on this machine, and fixtures are furnished for cutting internal ratchet teeth and polygonal shaped orifices of various kinds.



KEYWAY CUTTER.

The cutter bar having an upper and lower support is held securely against any tendency to spring away from the work, and the construction is such that no chips or fine particles of iron can get into the bearings below the cutter, as the chips are certainly conducted out and away from the working parts of the machine. A centering plate is furnished with each machine, with a set of bushings for different size holes. With this device work can be chucked accurately by its bore, and the keyway cut central.

A new device for the reverse motion has been added, which is shown at the side of the main frame. It consists of a shifter rod with an upward projecting end traveling in suitable bearings. Pivoted to a fulcrum slightly above this rod is a weight lever whose lower end is slotted lengthwise. On this end is fixed a block which is bored out to receive the stud clamped to shipper rod between its two bearings. When either of the tappets on the stroke regulating disk strikes the upward projection of the rod, the motion thus imparted to it is used to reverse the machine through the medium of a shifting fork and internal shifter rod traveling inside of the rear shaft, and operating a pair of friction clutch pulleys. The weight being thrown by this movement gives an additional impulse to the shifter rod, and insures a better grip on the friction pulleys. Resting as it does on either side of the center it exerts a continuous pressure on the rod, thus effectually preventing all tendency of the clutches to slip.

The cutter bar has a quick return, which movement is accomplished by different diameters of driving pulleys. All gears and bearings are protected from chips or dust.

A set of four extension arms not shown in engraving are furnished with the machine. These are attached to table, and are for supporting the rims of large pulleys, gears, etc.

These machines are built in four sizes having a range which will cover all kinds of keyseating from work with a $\frac{1}{2}$-inch hole to the largest fly wheel.

We have previously given diagrams showing some of the details of construction.

Knowledge So Near and Yet So Far.

With our eyes wide open, the seeing of things directly in front of them is generally thought to be unavoidable. We have, however, a plenty of evidence that a thing may be in plain sight of a person whose vision is undoubtedly good, and that still he may utterly fail to see it. Not long ago, we are told, they were testing the revolving friction of railroad axles, and attention was called to the apparent ease with which the box would move longitudinally while the axle was revolving. "This phenomenon of friction proved a marvel to all who witnessed it.

Th temptation was great to theorize upon the extraordinary performance, but no theory was offered in explanation of it."

As we understand it, the axle was supported and made to revolve at various speeds from 160 to 400 revolutions per minute, and boxes having about 14 square inches of bearing surface were placed upon it, and variously loaded, from 262 pounds upwards. One box could be moved longitudinally with a thrust of 1 ounce when the axle was running, but required 32 pounds to move it when the axle was still. Another showed 4 ounces with motion, and 40 pounds still, and a third, under greater pressure, showed 6 ounces running, and could not be moved by the strength of one person when the axle was still. No hint is given us of the distance moved, or of the time occupied in the movement, although we have reason to believe that the experimenter is not ignorant that such data are necessary in all cases of power computation.

This "phenomenon" has been shown up before in the AMERICAN MACHINIST, and probably elsewhere, but we may be permitted to bring it up again for the sake of calling attention to one point in connection with it that may have escaped general attention. The probability is that as much power was used in moving the box endwise upon the axle while it was revolving as was used in the motion of revolution, in proportion to the distance traveled in each direction in the same time. Say that *A B* represents the line of movement in revolution without any longitudinal motion, and *C B* a certain amount of longitudinal movement, then *A C* would represent the actual line of movement when the axle (or box) were moving longitudinally at the same time that the axle was revolving. Say that the axle bearing was 3½ inches diameter, and at 200 revolutions per minute, then the distance traveled per minute would be $3.5 \times 3.1416 \times 200 = 2,199$ inches. Say that while the axle was revolving at this rate a thrust of 1 ounce would move the box endwise 1 inch in a quarter of a minute, or 4 inches per minute. To get the thrust that we might expect for the speed of revolution, we then have the simple proportion 4 : 2,199 : : 1 : 549, and when we remember that 1 ounce is to 32 pounds as 1 : 512, we are not so terribly out of the way from the first instance cited above.

It is, when we think of it, a rather peculiar position that is held by the junior partner of a composite force. Something that could not possibly be budged by that force acting alone may be shoved considerably out of the way by it if it happens to get a side push at the thing while a greater force is moving it in any direction. In other words, what is powerless alone counts for all that it is worth by association with a powerful partner. We often see a countershaft that is revolving at a high speed at the same time playing gently back and forth endwise, as though the shaft were without friction, and were simply floating in the box. The fact, however, always is that the shaft never plays endwise without a cause, and never without a force acting upon it sufficient for the friction to be overcome. When a countershaft plays endwise, the cause is usually either a crooked or a swaying belt, but whatever it is it always applies a force in a direction that is not absolutely at right angles to the axle.

The one thing that we seem to have missed in this case, and the thing that may after all be of the most value to us, is that the measure of the force that causes the end play may also be made to tell us of the friction of rotation. The junior partner of the firm carries the secrets of the firm, and may be made to divulge them. With the figures precisely as we instanced them above, *B C* : *A B* : : 1 ounce : 549 ounces = 34.3125 pounds, this last is the friction of the bearing in the direction of the rotation.

This matter is worthy of further thought than we have given it here. Minute measurements of end thrusts of revolving shafts, in connection with the time of the movement, would seem to be capable of giving us much information as to the friction of revolution in cases where it would be otherwise difficult to ascertain it. The motion in the bearing endwise may be so slow that the inertia of the mass that is moved will not be an important factor in the case. It is, however, difficult to revolve a shaft, and at the same time move it longitudinally without some other friction besides that of the bearing. If driven by a spur gear the teeth must slide endwise upon each other to allow the shaft to move in the same direction, and of course, this friction of the gear teeth would not belong to the friction of revolution. Shafting driven by belting might be affected in its longitudinal movement by the pull of the belt, but it might be possible to ascertain the "personal equation" of the individual belt, and make allowance for it. A long wire rope, if it did not sway sidewise, could do little or nothing to cause any end movement of the shaft.

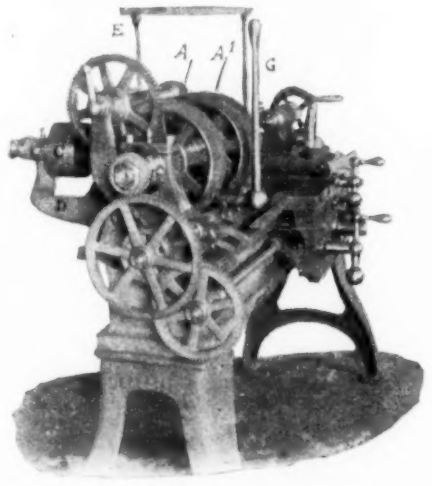


Fig. 18.

The Shops of the W. F. & John Barnes Co.—III.

BY JOHN RANDOL.

Not less novel than the bevel gear cutter designed by Superintendent Frank Barnes, is the manufacturing lathe designed by Fletcher Barnes, and shown in Figs. 17, 18, and 19. This is 16-inch swing, six and eight-foot bed, back geared and screw cutting; the novelty lies in the friction driving of the spindle as well as in the feed and cross feed actions. In place of the belt cone on the lathe spindle is a loose flanged sleeve; the flange stands at the forward end of the sleeve next to the large back gear, which is fast on the spindle as usual; the flanged sleeve which occupies the cone place on the lathe spindle carries, besides the locking flange at the front end which locks the sleeve to the large back gear, two large leather faced friction wheels, one pressed tight on the sleeve at the back end, and one sliding on a feather on the sleeve; either of these large friction wheels, *A*, may engage with a large gray iron friction disk *B*, carried on a short horizontal shaft at right angles to the lathe spindle and carrying the driving pulley *C*, which is driven constantly at a uniform speed from the overhead line shaft, also standing at right angles to the lathe spindle. This friction disk shaft is journaled in a swinging head *D*, so pivoted as to carry the face of the friction driving disk in an approximately parallel position to the lathe spindle; the position of this swinging head is governed by a rocking spiral grooved cam operated by a lever *E* and shipper bar *F*. The effect of moving the lever *E* to the right or left is to press the friction disk *B* hard against one of the spindle driving friction wheels *A*, *A'*, and against only one. When the lever *E* is tilted to the left, the friction disk *B* is forced against the forward driving friction wheel *A'*, and drives the lathe spindle forward; when *E* is tilted to the right the disk *B* is forced against the left-hand friction wheel *A* on the lathe spindle, and drives the spindle in the other direction. The forward friction wheel *A'* slides on a feather on the friction wheel sleeve which runs loose on the lathe spindle, consequently the disk *D* can drive *A'* fast or slow, according as *A* is near the outer edge or near the center of *B*. The position of *A'* is governed by the lever *G*, which operates a rock shaft and clutch fork in the usual manner to slide *A'* along the splined sleeve loose on the lathe spindle. Thus the operation of *F* is precisely that of the ordinary shipper handle; if *F* is moved to the left the lathe runs forward; to the right, backward. Swinging the lever *G* moves the spindle driving wheel *A* across the face of the driving disk *B*, and has the same effect that follows the shifting of the driving belt on the cone steps of a lathe: the spindle is thereby made to run faster or slower.

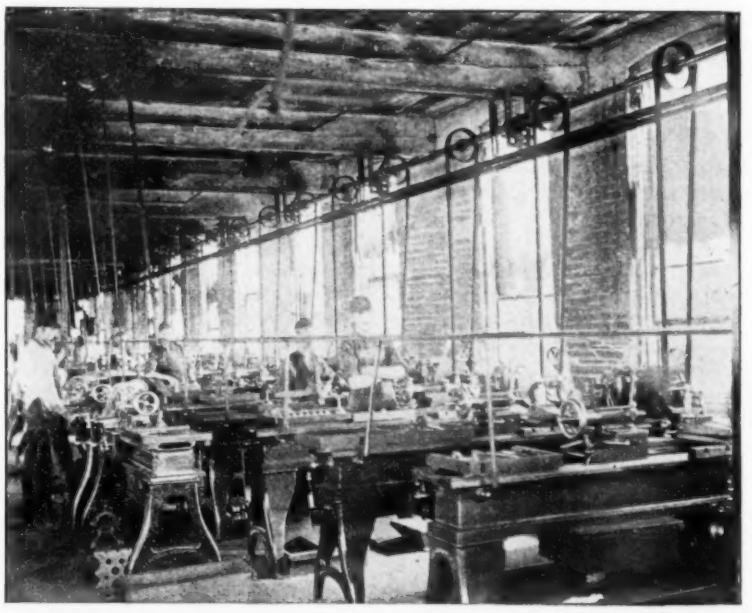


Fig. 20.

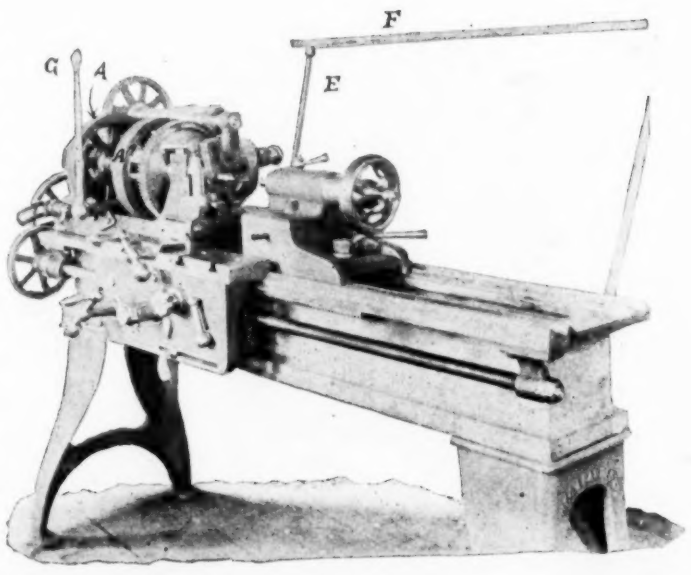


Fig. 17.

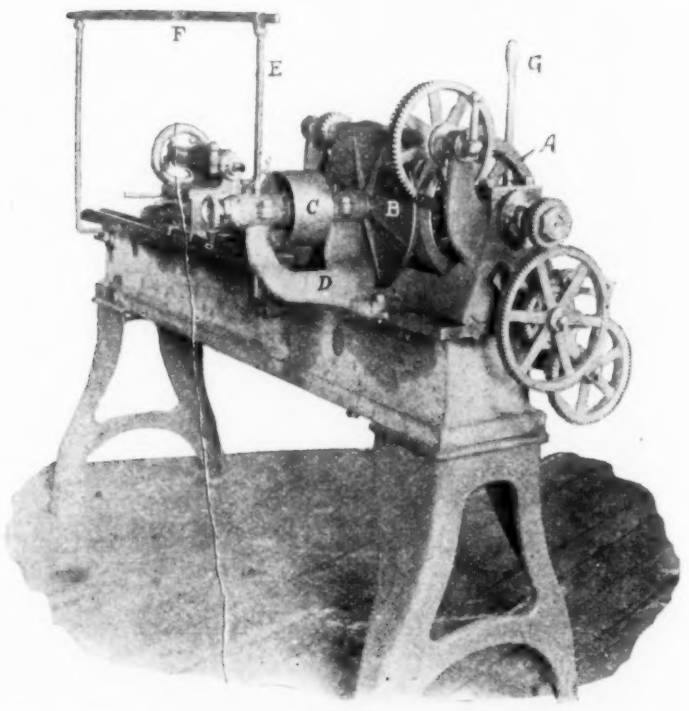


Fig. 19.

SPECIAL MACHINERY IN THE BARNES SHOPS.

The movements of the carriage and cross

feed are obtained in the same manner, from disk-driven friction wheels on the inside of the carriage apron; by this means both the spindle speeds and the ratio of spindle and carriage feed speed may be changed instantly through the whole range of speeds of either feed or spindle. The back gear is of ordinary construction, placed high to clear the driving disk *B*, and needs no other mention.

There is no countershaft whatever for this lathe, and in place of the two belts from the line shaft horizontally to the countershaft, and then a vertical belt from the countershaft to the lathe spindle cone, there is only one belt used. This is a vertical belt from the line shaft at right angles to the spindle, to the friction shaft driving pulley *C*, which runs all the time, and required no handling.

The first of these lathes was built in 1890, and gave such excellent satisfaction that it was decided to build a lot of 25 to replace 16-inch lathes of various makes in use in the shop. This was done, and 19 of these lathes stand in a row and are driven from one line of shaft as shown in Fig. 20. In this instance the belts run close to the wall and neither belts nor line shaft pulleys make much appearance in the engraving, nor are they prominently in evidence in the shop. The lathes look as if they were electric driven, so wholly unobtrusive is the belting. Of course these lathes naturally stand across the shop at right angles to the line shaft, which is in every way a great saving of room and also adds greatly to general convenience; the lighting is excellent and each lathesman has his own place to himself, and if there is a line of bench at the head of the lathes might have his own vise (as is needful in certain classes of work), in reach by a couple of steps. I tried a piece of steel 4 inches diameter in one of these 19 inch lathes, and found the drive strong and the feeds very easily managed. The lathe first built has now been in constant use for four years, has had no repairs, and is in perfect order to-day.

The advantages of this extremely novel form of lathe drive are as follows: One belt in place of three. No countershaft, no countershaft clutch, no overhead belts, no loose pulley, and those four things call for a great part of all machine shop repairs. No shifting of the cone belt to change speeds. The vertical driving belt is never shifted, hence never touched, and hence is very durable. The up-and-down cone belts of lathes wear out very rapidly; not so with these; they do not seem to wear at all; there is no reason why they should wear, as they can be any desired width and run on pulleys of any desired size; there is no limiting condition in the machine to make a small driving pulley almost a necessity. The belt power delivered to the machine is uniform.

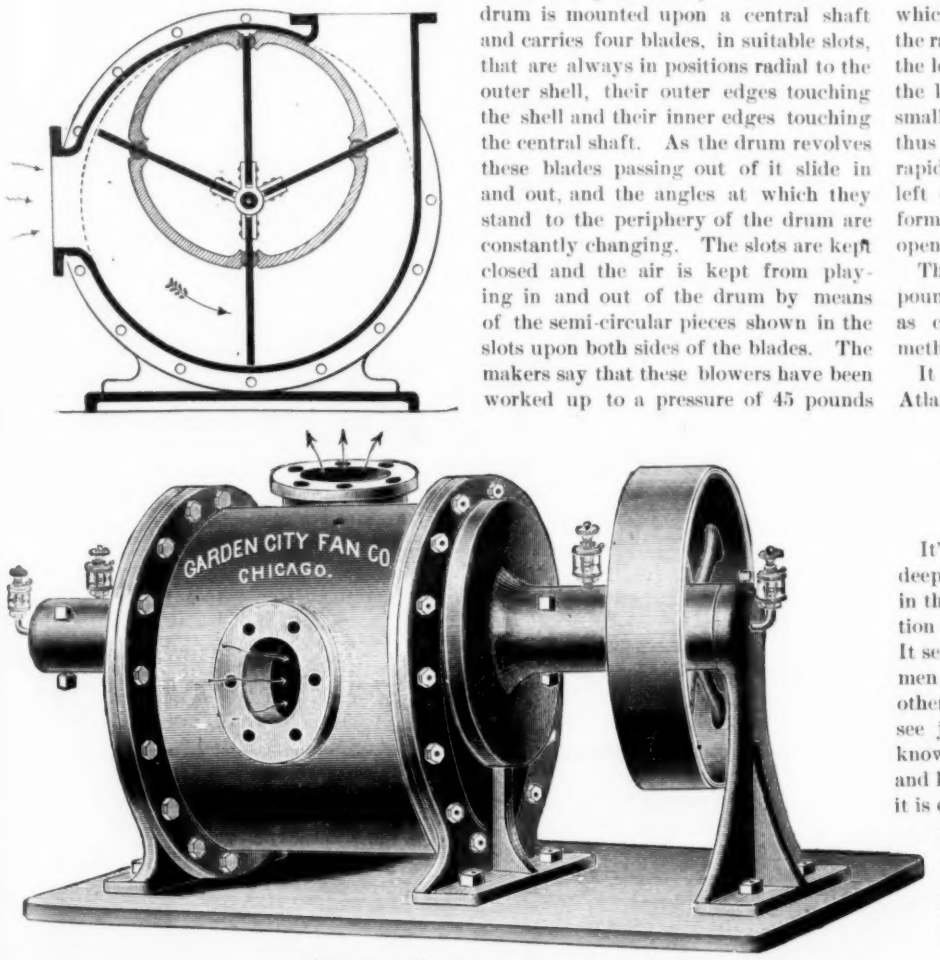
There is a great saving of time in changing speeds and reversing, and another saving of time in changing feeds. A workman will change the feed often and keep all the feed he can carry if he has not to move out of his tracks to make the change. If he has to move away from the carriage he will not be nearly so likely to make the change for small differences. With this friction-driven carriage the feeds can be changed and reversed while the lathe is taking a chip; the workman does not have to exert much muscular force to make the changes; there is no friction to screw up and unscrew; a single half turn of a crank, unloaded, puts the carriage feed on or off, and the cross feed is of equally easy manipulation. No two feeds or carriage operations can be put in action simultaneously, so there is no danger of breakdowns from such an oversight.

The care and cost of belt maintenance is done away with. Any shop of much size must keep a man working on the overhead belts all the time. All of this expense for lathe belt care and repair is saved by the use of this style of machine, as well as all the loose pulley and clutch repairs and readjustments, and the overhead oiling, except for the line shaft, is also done away with.

Lastly, these 19 lathes in the Barnes shop take over five horse-power less to drive them than the lathes required which they replaced.

A New Positive Pressure Blower.

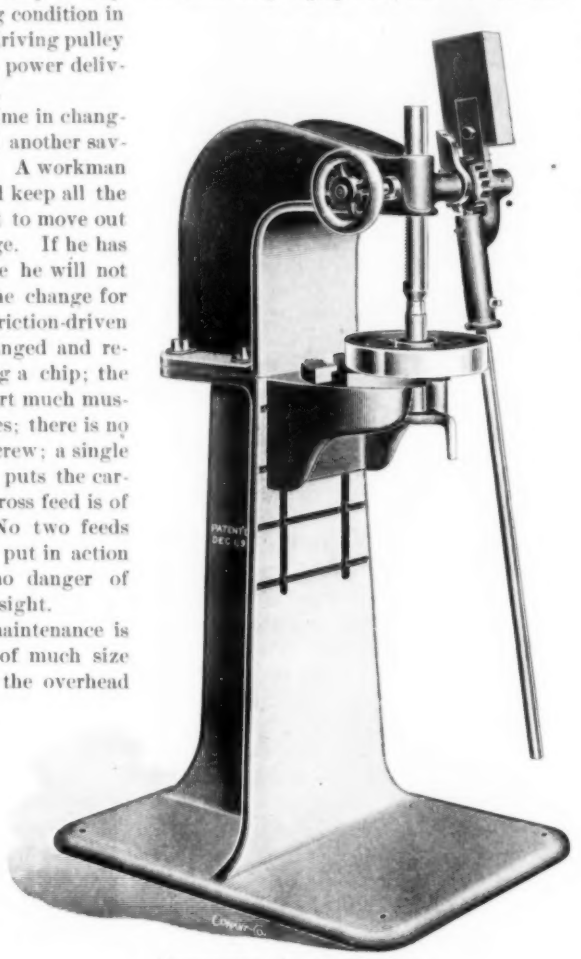
We present a perspective view and vertical section of a new pressure blower, the latter cut showing the operation of the blower quite clearly. The eccentric drum is mounted upon a central shaft and carries four blades, in suitable slots, that are always in positions radial to the outer shell, their outer edges touching the shell and their inner edges touching the central shaft. As the drum revolves these blades passing out of it slide in and out, and the angles at which they stand to the periphery of the drum are constantly changing. The slots are kept closed and the air is kept from playing in and out of the drum by means of the semi-circular pieces shown in the slots upon both sides of the blades. The makers say that these blowers have been worked up to a pressure of 45 pounds per square inch. Compressors of this type find an extensive field of usefulness in the middle ground between the fan blower and the air compressor. They are made in ten sizes by the Garden City Fan Co., Chicago, Ill.



POSITIVE PRESSURE BLOWER.

Improved Greenerd Arbor Press.

Some form of arbor press has come to be one of the well recognized features of machine shop equipment, and we illustrate one of the latest of these, or rather the latest form of a well-known press.



IMPROVED ARBOR PRESS.

As shown, the press is made to stand upon the floor, instead of being placed upon the lathe bed, and has a knee with a tongue made to fit the horizontal slots shown in the front of the upright to which it is secured by bolts.

The plunger is moved by the lever shown, which is provided with a pawl to engage the ratchet wheel shown at the right. When the lever is thrown up the shedder seen at the left of the ratchet wheel acts upon the small pin seen, and withdraws the pawl, thus leaving the plunger free to be moved rapidly by the small hand wheel seen at the left of the machine. The platen is in the form of a turntable with various sized openings.

The machine as thus made weighs 650 pounds, and is very efficient and satisfactory as compared with the usual pounding method.

It is made by C. F. Harlow & Co., 364 Atlantic avenue, Boston, Mass.

Jobson Builds a Steam Engine.

BY FRANK GLEASON.

It's a wonder, if you don't think very deeply over it, how many mistakes are made in the machine business by the misapplication of rather well-known general principles. It seems to come a good deal easier for some men to misapply things than it does for others, and it isn't always an easy matter to see just why. Of course, if a man doesn't know anything about the machine business, and has a rather unbalanced head anyhow, it is easy enough to see through it all, but this wasn't the case with Jobson. On the contrary, Jobson was credited, on pretty sound principles, with having a mighty level head, and had the reputation of being a good mechanic.

He had a little machine shop, in a small New England town, and rustled for the repairs for a lot of small mills in the hills all around him—rustled for the repairs in the old mills and the machinery for new ones, and he got and deserved to get the work, too.

These little mills were run by water power, but after a time the brooks began to dry up, and some of their owners got talking about putting in small steam engines to turn the water wheels round in the dry season. You know, Mr. Editor, it is the practice, come down through generations of small mill owners all over the country, to put in a steam engine to do the work and tie it right up with dragging a water wheel that will not run itself; doesn't seem to be much conception of any other way to get power when it is wanted than through the water wheel shaft; always had gone through that shaft, you see.

Jobson knew more about mill spindles, and points, and steps, and cockbills and the like than any man in that part of the State. His father had known these things before him, and he was residuary legatee, with a good deal of added experience.

Jobson knew all about these things, but when it come to steam engineering there was a deficiency in the matter of education, and unfortunately, as it happened in his case, he didn't know it; wasn't troubled with big-headedness or anything of that sort, but just didn't know it. That was all the trouble with him, and that's a very common malady whether it comes in the line of mechanical knowledge or in some other line.

Jobson's mind was set on steam engineering, and wherever so good an opportunity to show what he knew and make a little money? All these little mills had to have a steam engine, and that meant business for him if he only got the initial move in the matter, which was a way of looking at it that showed that he didn't represent the fool element—if there was such an element—in his family.

Then, Jobson thought it would be a proud day for him when he saw a real live steam engine going out of his little shop. This was evidence of a sound state of mind, just as were the thoughts of enlargement of business and something in the way of fame. He would build, so he thought, a genuine healthy center-crank engine—build one for every little mill in the big county, and then look for new fields.

But Jobson wasn't reckless. He sort of formulated his ideas about steam engines, and then he went 20 miles to see an old friend of his, Orton, both graduates in the same class, from Stoker's machine shop. Orton, so he had written Jobson, had just put in a new 15 horse-power engine, and it was a "daisy." That is, the engine or the boiler was 15 horse-power—couldn't just remember which, and didn't suppose it made much difference.

Jobson looked at Orton's engine from both sides, then he looked at it from both ends, and finally he got on a barrel and looked down on it—getting mental elevations and plan, so to speak.

Finally, turning to his friend, "See here, Orton, that's a pretty engine enough, but it's all wrong—all wrong, and that's pretty much all the fault I can find with it. Can't you see it's all wrong?"

Orton couldn't see it—whoever could see anything wrong in a steam engine after he had accepted and paid for it—paid for it, mind? Said he bought that engine to do his work, and it was doing it without complaining; run smoothly and quietly, and that was what he wanted an engine to do.

"Come here," said Jobson, leading the way to Orton's line shaft, "what's the diameter of that shaft?" "Two inches," said Orton, "according to rating."

"Well, how long are the bearings?" "Eight inches."

"Why," continued Orton, "did you make them eight inches long?"

Orton allowed that he saw a lot of shafting and hangers up at the Big Mill that had just come from Philadelphia, where he had always heard they knew a good deal about such work, and he noticed that the boxes were four diameters long. So he concluded that he would get the benefit of what some other fellow knew about line shafts. One man wouldn't live long enough to find out much by experience, so he had found it best to learn a good deal from observation—just by seeing what the successful practice of

others was. Jobson rather ignored Orton's explanation, but he stuck hard to the fact that the journals were four diameters in length.

"I've been," he said, "reading up a good deal lately on journals and bearings, and friction, and the conclusion I have come to is that four diameters is the right length for a journal. That's just what you have made yours, from observation, and it shows good judgment on your part. I find the journal must be small to keep the surface velocity low, and it must be long so as to keep the pressure per square inch low. That's reasonable, and it's just what you and I have been practicing for years—been practicing without ever knowing it. Why, if we ever stop to think, we got a good lesson when, as cubs at Stoker's, we used to climb the ladder, with an oil can, to pacify his line shaft journals, not a bit over three inches long, all the time thinking we ought to be doing the best work in the shop. What you want is small journals and long ones; all the laws of friction point this out. If you can't get them as small as you would like, get them long.

"Now," said Jobson, "just take a good look at the journals on your line shaft, and then at those about your engine. They don't consist. Journals on your engine ought to be twice as long as they are—every bit of twice as long, and smaller. However, let the shaft go as it is, and with journals twice as long as at present, don't you see that you have got something to hold the shaft right up to its work? I believe the shaft is too large anyhow. Whoever heard of a stationary engine twisting off a crank shaft?"

Orton never did, to be sure.

"Then," Jobson went on, "look at that crank pin, it's just as big one way as it is the other, just as big in diameter as it is long. Orton, it's simply outrageous. That engine was made to sell. Nothing else in the world ever entered the mind of the designer. The commercial side is at the front, no mistake.

"Don't you remember Strikers' engine, pin outside the crank, just 3 inches diameter, and the engine had a 12-inch cylinder? The pin was large enough, but it wasn't long enough.

"Now, Orton, I'm going to tell you something, right down in confidence. I'm going to do a good business in building steam engines, unless an eccentric slips, and I'm going to do it because I shall make every journal four diameters long. I am not prepared to say what size I shall make the crank shaft, but I don't mind telling you that the crank pin will be just about half the diameter of the shaft."

Jobson built his first engine right up to his views of steam engineering as a science. When he got it done—all assembled—the eccentric rod started off boldly enough into straight-ahead space, then wandered back towards the cylinder in an uncertain sort of a way, the outline of its wanderings resembling the map of the crooked county that was the wonder of his schoolboy days.

Then he had to put up a frame, with bearings, and a shaft and two pulleys to get the governor belt where it would do duty, and heavens! what a throat in the frame between the two main bearings. But the main journals and the crank pin were four diameters in length. No one could dispute that.

Jobson got the engine done at just the right time. Kirby, who had a mill 14 miles up the Lower Branch, had heard that he was building an engine, and came in the next day. He had had a long, busy time of it, and had drawn all the water from his reservoir, and had lots of work to do yet. He had got a boiler, and now he wanted an engine. Jobson explained the good points of his engine, and Kirby concluded to give it a trial. Said it was rather against his judgment; didn't know much about such things anyhow, but that engine didn't seem to stand in with his early recollections of steam engines. Seemed, he thought, to wander around like over too much floor space.

"Of course," said Jobson, "it doesn't look like any other engine you ever saw. Wasn't built just to sell, that engine wasn't. It was built to stand right up to its work, and run 50 years, and then be just in its prime. You try it, Kirby, and if you and I live to see it give out, I'll take it back and pay expenses. Why, you nor no one else ever saw a steam engine with a crank pin four diameters in length, and with main journals similarly proportioned."

The engine was put in place and started up. Kirby called Jobson's attention to the wabbly behavior of the fly wheel; didn't seem to know, he said, just which way to wabble next time around, which was a good way of putting it.

"Yes, I see," said Jobson, "that's Tom; just Tom, and nothing else; he didn't turn that wheel true. When the wet weather comes I'll take it back, make Tom turn it up true, and pay the expenses."

Then Kirby got along with his investigations as far as the eccentric rod.

"Just looks," said he, "as if that rod was crookeder than ever."

Jobson explained this by saying that it trembled a little, but would keep quiet as soon as the valve and seat got smoothed up.

"Now," Jobson went on, "just see how nicely those long journals behave," putting his hand on one of the cups, and taking it off a good deal quicker than he had put it on; "getting a little warm, and so, of course, is the crank pin. That's always the way with a new engine. We'll shut her down, and give her a few pails of water, then you can start up, and run a little slow for a few hours, give the journals lots of oil, and you'll have no further trouble. These long journals are sure to win."

Jobson went home, and two days later received a message from Kirby to the effect that, if he had any special interest in the remains of that engine, he had better come and gather them up.

Jobson sorrowfully gathered up a shaft with a broken pin, a broken cylinder, main bearings with babbitt melted out, a doubled-up eccentric rod, to say nothing of various other disorganized parts and pieces. He gathered them up sorrowfully, if not tearfully, and proceeded to hold a *post mortem*, without a jury. He studied the case for three weeks, and has the conclusions in his note-book as follows:

"Do not make the length of main bearings more than two diameters, but get them that length, if practicable. When you go beyond that there is danger.

"The crank pin of a center-crank engine is virtually part of the crank shaft, and being centrally located between supports, should always be as large as the shaft. Theoretically it should be a little larger, but never smaller.

"To avoid springing and undue spreading of the frame as much as it is practicable to do, the length of the pin should never be more than one diameter. Unduly spreading the frame is in the way of weakness, and brings about various unsatisfactory complications.

"If at any time there is doubt as to the probable behavior of a crank pin of large diameter and short in length, hunt up some old locomotive engineer who has run the old-time Hinckley inside-connected engines; he will be very likely to tell you that the crank pins were less than half their diameters in length, and that they gave less trouble than any other journal about the engine.

"The foregoing applies distinctively to center-crank stationary engines; if it is applicable to other engines, that is none of my business.

"Mem.—When you try to build a steam engine, just as when you try to build anything else, bear in mind that all machine construction is mainly a matter of compromise; just compromise, and not much else.

"Mem.—To tell Tom that I have finally concluded that he made a pretty fair job turning that fly wheel, and that he needn't turn it again."

LETTERS FROM PRACTICAL MEN.

Engine Setting.

Editor American Machinist:

Having read with interest the different methods of engine setting advocated by different mechanics, with your permission I will express my opinion, and what I think the best method of engine setting.

In building the foundation, I would make ample provision for the adjustment of bolts. For instance, in placing foundation bolts in position I would incase each bolt in a suitable box or pipe, giving about 1 inch clearance. This box or pipe prevents the mason from building the bolts solid in masonry of foundation. This provision also gives you a chance to overcome any mistake made by draftsman, builder of engine, man placing foundation template in position, or mason in building foundation.

After I had built foundation to a suitable hight, instead of using the coping stone, I would use a cast-iron plate, large enough to cover the foundation. This plate would be planed to a true bearing for engine bed proper. This cast-iron plate I would fasten to foundation by bolts, independent of engine bolts. Now it is understood the engine builder in building the engine, planes the base of engine frame true with the working parts of engine, and the base plate that takes place of the coping stone is made strong enough to avoid chances of springing by being bolted to foundation, and is planed to suit base of engine frame; the bolt holes in plate would be large enough for adjustment. I would have lines drawn upon the base plate representing the center line of cylinder, and a right-angle line representing line of engine shaft, and in the base plate I would have suitable holes cast, say, 6 inches diameter, at different parts of plate, these holes to be used in bedding the base plate to foundation. All this being understood, and the foundation being ready for placing of base plate, I would place it in position to see if all parts came to proper place, then raise base plate, put a thin layer of cement on foundation, put base plate in position, and then start to bolt the base to foundation, in doing so be careful to keep the plate level and in proper line. I would use no wedges, no strips of iron, no sheet lead, no sulphur, no iron borings, nothing but good cement, same as used in building the foundation. Taking for granted the setting of base plate has been well done, that is, set level and to the proper lines, we are now ready for placing of engine. Before so doing let us question the room left for adjustment in bolt holes; place the engine over the bolts, see that all come right to place, then raise engine off of plate high enough to permit the pouring of cement down each bolt hole. Then, before cement has time to set, let engine in place on base plate. After following these instructions, what have you got? I think you will have an engine setting that will repay you for the trouble. You will have an engine setting that will keep your engine in line. This method you will find good for hoisting engines and pumping engines as well as the ordinary stationary engine, and when you keep the engine in line it takes very little to keep it down. In fact, in erecting water-works machinery I would hold the water end rigid and firm, the steam end I would give a chance to overcome expansion and contraction. Hoisting engines I would set by having two cross plates on foundation, so that when engines were in position they would be held in line by these cross plates.

Lee Whittaker.

Allegheny City, Pa.

Stresses on Pressed-in Crank Pins.

Editor American Machinist:

It is fair to infer from your note appended to my letter of May 16th, that you think the crank pins of locomotives have more need of being securely fastened than does the pin in Professor Sweet's Straight Line engine. In regard to this I would like to offer a few suggestions.

The crank pin of the American type of locomotive, with outside cylinders, has no twisting stress whatever upon it, except that due to the friction of the brasses upon it. The construction of the Straight Line fly wheels is too well known to need much description, but it may not be amiss to recall it briefly.

The fly wheels are between the frames, or rather within the frames, and are connected by the crank pin which is forced into both of them, as are the shafts; the main bearings being immediately outside the wheels and the fits for driving pulleys, clutches or the like are outside of these again, the fly wheels never being used to belt from. It will be seen that at least half the twisting stress developed by the whole engine must pass through the forced fit of the shaft into the wheel on one side or the other, and all of it may and very frequently does; not only this, but the energy given out by the heavy fly wheels when a sudden increase of load takes place is added to it, and in some cases a heavy pulley on the opposite shaft may act as a fly wheel *through* both shafts and the crank pin.

One case that came to my knowledge was where there was a heavy seven-foot pulley on each side of the engine, one of which did all the driving, while the other was admittedly for more fly wheel, the load jumping from nothing to 300 horse-power on a 125 horse-power engine at intervals of a few seconds.

If the editor says that there is greater need for a key in the crank pin of any locomotive that ever was built than in that shaft, of course I shall have to believe him; but I shall consider that the friction of locomotive crank pins has been greatly underestimated.

Longdale, Va. J. E. Johnson, Jr.

[Mr. Johnson's remarks about the stresses borne by the fastening of the crank fly wheels to the shafts of the engine named are, no doubt, correct; but reference to our note spoken of will show that we were considering crank-pin fits only, and we said that "locomotive crank pins probably have more need to be securely fastened in place than any other crank pins whatever." We still think so; for it is to be remembered that there is no more twisting force applied to the Straight Line *crank pin* than to others. And we think that the character of the service performed by locomotives—their excessively high piston and rotative speed, their slipping and suddenly gripping again, and the shocks due to the conditions under which they run test the fastening of their crank pins more severely than the same detail of any other form of engine is tested. Very many crank pins of locomotives have been broken short off in service—an accident which is very rare in other forms of the steam engine. —Ed.]

Some Things He Wants to Know.

Editor American Machinist:

A long while ago I wrote some of my wants which you kindly published, and to most of which your correspondents returned satisfactory answers. To all save one, and that was that I wanted to find a monkey wrench without a weak back. This conundrum stands unanswered.

In view of so many fly-wheel accidents, I want to know if it would not be better to discard the usual beautifully spoke-shaved sharp-edge oval arms and substitute wide arms, standing edge on with the plane of rotation, of course. I would like to know if the thin edge of the oval arm is not liable to crack the least bit on the edge in cooling, and then when the rim shrinks do not the cracks close up and hide themselves until the day of doom, when they maliciously let go?

I would like to know how much nourishment and vitality this "Balanced Locomotive" scheme drew from a short article in the American Machinist a few years ago.

I would like to know if you approve of the habit some of our friends, your correspondents, have of prefacing a strong point—sometimes strong—with the words "Now, then!" These words seem to me about as useless as the preliminary jingle of a blacksmith's hammer when about to give

a good clip. Why would it not be better to put the extra energy they lost into the clip?

And again, why would it not be better to say "I" when "I" is meant rather than make a pretense of modesty in saying "the writer?" The latter form costs more and shows no less egotism than the former, it seems to me.

I would like to know if circular architects would not do better by exploiting the excellencies of their own productions rather than pay for ink and paper to belittle the products of their competitors.

I would like to know if an entrained water separator on the principle of the centrifugal cream separator would not be a good thing.

I would like to know if, on general and scientific principles, a cross compound steam engine with the cylinders as near as possible together and the cranks at 180 degrees, will not deliver more power to the belt than a tandem.

BENJ. F. WILSON.

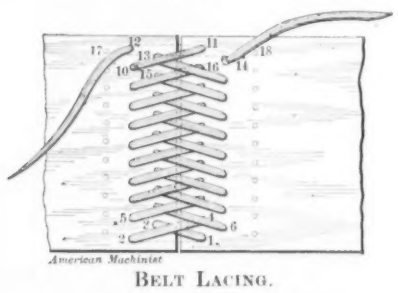
Belt Lacing.

Editor American Machinist:

Every engineer has some pet way of lacing belts, myself among the rest.

The hinge joint described by Mr. Davidson, May 2d, I have never yet found necessary, and I believe that if an instance is found in which the system which I am about to describe will not hold, that it is time to glue the belt and do away with lacing altogether.

I will proceed to the description of the system which I have used for a number of years. It is called the "herring bone," and was given me by Professor Beardsley, of Swarthmore College, Pa. I have since



BELT LACING.

found it in favor with other engineers, and believe it has been accepted by the Franklin Institute.

By reference to my sketch, which, by the way, is free-hand with a stylographic pen, but in my present position (a hospital bed) the best I can give, it will be seen that two rows of holes are used. My method of laying out these holes is just as they are drawn—free-hand. I begin in the middle of the belt, and by eye punch a hole in center of first row, then at distances equal to double the width of lace to be used I punch the rest of the row each way. Back of these I then punch the second row with the holes staggered with those in the first, and one more or one less, as the distance of the outer holes of the first row will decide.

The other end of the splice is punched in same manner, except the row with middle hole is the back row.

In lacing I begin at one side and draw the lace up through the two end holes nearest the edge, as seen at 1 and 2; 1 is then passed down through 3, the inside hole on opposite side, and 2 is passed down through 4 again an inside hole. Both are brought

Side of Splice next to Belt

up through 5 and 6, outside holes directly opposite 3 and 4 respectively. Continue in this way all the way across, always passing the lace down through the hole in the opposite inside row, and up through the opposite outside row in all cases.

I have shown the ends free because their fastening would complicate my sketch. To fasten them, 14 should be passed down through 13, up through 15, and along under all the outer plys of the lace. It will never come loose. 12 is likewise passed down through 11 up through 16, and under each outside ply on that side, and there is no knot or thick place about the whole splice.

The other advantages are that a complete sheet of lace leather covers in single thickness the lower side of splice, and each ply is parallel with length of belt. Also in passing over small pulleys the distance between holes is enough to allow all the hinge motion required. While perhaps the greatest advantage is simplicity.

My experience ends with 16-inch belts, but up to this width I can speak with reasonable certainty. I have never found it necessary to double-lace, but in cases of large belts heavily worked it may be sometimes necessary. In such cases I would suggest punching two more rows of holes one on each side of splice similar to its inside row, and then after the lacing is carried as far as shown in sketch, instead of fastening ends there, pass 12 down through 11 and up through 18, and pass 14 down 13 and up 12. The two ends will then be in same position as when starting at 1 and 2, and the two outside rows of holes are to be used in lacing back to beginning. The double lace thus formed will have the advantage of entering the pulley single, and a sudden jump is avoided. I have never seen this idea expressed elsewhere, and have never had to use it myself, but it appears to me to be a most excellent system, and I give it to show the adaptability of the "herring bone" to double lacing.

SPLICING THE LACE.

In lacing wide belts one or more splices in the lace are necessary. I inclose a sketch of the lace-splice which I have been using for a number of years. It needs very little description beyond insisting that the side of splice shown should be placed next the belt to hide and cover the loose end. When I have to use two laces, I start with one, leaving the long end about right to reach across. When the short end runs out I cut off the taper end, and slit it as shown, make splice, and continue lacing.

In regard to lace leather, many seem to prefer to cut their own laces, even to hanging up a side of leather for all comers to haggle at. My experience, however, is altogether in favor of buying cut laces. I have bought them both east and west, north and south, and have never been served with an inferior quality of goods, and I consider the saving in time and the advantage of uniform width easily pay for the whole cost of the cut laces.

The sizes that I have been in the habit of using are $\frac{1}{4}$" up to $1\frac{1}{2}$" belts, $1\frac{1}{2}$" to 3", $\frac{3}{8}$" lace, 3" to 6", $\frac{1}{2}$" lace, and 6" to 20", a $\frac{5}{8}$" lace. Above 20" a $\frac{3}{4}$" or a 1" lace might be used to advantage. In all cases the punch should not be larger than necessary to nicely pass the lace used.

THE CARE OF BELTING

is very often so much neglected in shops and elsewhere that a great loss must be sustained.

In machine shops each machine hand is left to tinker and fiddle at his own belts, using a vast amount of both his own time and that of his machine, besides often turning to his own uses a large amount of lace leather. The tinkering when done may only last a day or so, and the whole performance will be gone through with again. No system is used, but the lacing is twisted, crossed and knotted, and the holes punched as artistic or inartistic as the men can make them.

In a few places the engineer has charge of the belts, but is allowed to fix them his own way at his own time, and too often no better result than above is obtained.

I have always contended that the proper way is for the superintendent of any works using belting to decide on some system, and then decide on a man to use it, be he the engineer or a floor hand. Next teach the man the system, using a club if necessary, and lastly, watching to see that all belts are kept in proper condition.

I am sure that many AMERICAN MACHINIST readers can vouch for my correctness in each of these systems.

I have gone to considerable length in discussing this question of belt splicing, but I am sure that the importance of the subject warrants all that I have said. I will be pleased to see further discussion by mechanical engineers on the subject, for I believe much good may be accomplished.

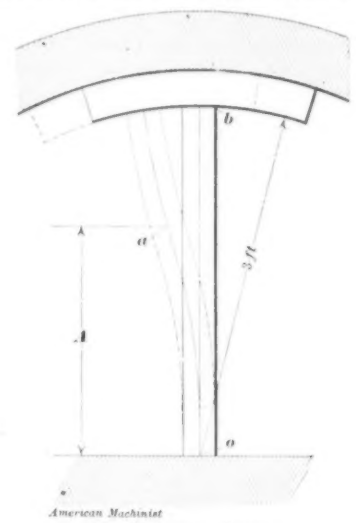
Montreal, Can. FRANK COWLEY.

Fly-Wheel Arms.

Editor American Machinist:

The following problem in mechanics has evidently an important bearing on the strength of pulley arms, and I have no doubt that some of your many readers can solve it.

A solid structure of some elastic material, and composed of an arm 3 feet long, with parallel sides and a curved head, as shown in the figure, is fixed at *o*, and the head fits closely against a solid circular wall with center at *o*, as shown. The head end of the



FLY-WHEEL ARMS.

structure is forced sidewise by a force equal to 100 pounds applied at *b*; the deflection is supposed to be very small, but to make it plain in the figure I have greatly exaggerated it, as shown by dotted lines. The arm will evidently be curved in the fashion shown, and there will be a point of inflexion somewhere, that is to say, there will be a point where the arm is not bent at all. Suppose this point to be at *a*, what is the distance *A*, and what are the bending moments at *o* and *b*? How would the solution be modified if the arm was tapered from *o* toward *b*? Would the bending moment at *o* be different for different shapes and sections of arm, or would it remain constant?

I have studied Mr. Guy's elaborate article in your issue of April 18th, but fail to find any answer to these questions, and am as much in the dark as I was before.

STUDENT.

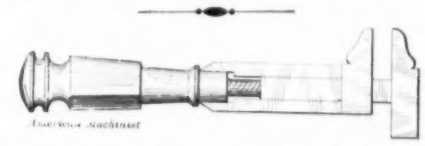
A New English Radial Drill.

We reproduce an illustration of an improved radial drill, built by James Spencer & Co., of Hollinwood, Manchester, Eng. The term "improved" as applied to this drill seems to carry something more than the usual perfunctory meaning. This machine is powerfully geared for drilling holes out of the solid to $2\frac{1}{2}$ inches diameter, and for boring to 9 inches diameter by 15 inches in depth. It will be noticed that the arm cannot be raised and lowered, but forms with the column, and the framing at the back for the driving mechanism, a single casting which may be revolved entirely around and secured wherever it may be desired. The means of transmitting the power to the machine are not shown, but we understand that it is driven from below up through the center of the column, and it could, of course, also be driven by a vertical central shaft extending down from a countershaft above. The saddle is adjustable on the arm by screw, and the spindle will work at any radius from 2 feet 2 inches to 6 feet. The hight of the spindle nose from the table is 3 feet 3 inches. The spindle is $2\frac{1}{4}$ inches diameter, carried in a long sleeve, with a conical bearing at the lower end, and an adjustment for taking up wear and keeping the spindle true with the base plate. The spindle has hardened steel washers to resist the pressure of the cut, and adjustments are provided to take up wear in feed screw and nut, to prevent the spindle from dropping when going through the hole. The bed-plate is 8 feet by 4 feet 4 inches by 1 foot 7 inches, with planed bolt grooves on top and on both sides. The saddle is also fitted with a self-acting traversing arrangement for cutting key grooves, etc., and can be adjusted to suit various lengths of traverse, and arranged so that the feed is put on automatically at each end of the slot. A stand is provided, so that when being used for slot-drilling the arm can be rigidly fixed in position, and the stand is fitted with a rising and falling table to fix work upon parallel to the travel of spindle upon the arm. If we may venture a criticism, we would suggest that the little crossed belt connecting the two small cones upon the carriage will give the drill runner more trouble than all the rest of the machine.

AN ENGLISH RADIAL DRILL.

Feeding Kerosene Into Boilers.

In our issue of February 26, 1891, was published a letter from Mr. E. E. Clock, in which he described and illustrated a device made by him for feeding kerosene into boilers. Mr. Clock called at the office a few days ago and said that a device which in every essential feature is just the same as the one described by him was subsequently patented by other parties who are now trying to compel those who made the apparatus from Mr. Clock's description to abandon it and purchase the patented device. Several have written Mr. Clock, asking him if after giving the matter to his fellow engineers he had changed his mind and secured a patent upon it, and he wishes us to say that he has not patented it, and that the device as shown and described by him in the issue named is absolutely free to all who wish to use it.



Blue Print From a Printed Page—An Old French Monkey Wrench.

The above cut of a monkey wrench was made from a blue print—which blue print was made direct from an engraving which was in a book. The method of doing this, as practiced by Mr. W. F. Durfee, is to soak the paper on which the engraving is printed with benzine, which makes it sufficiently transparent for the purpose, and the benzine afterwards dries out, leaving the engraving as good as ever. Incidentally, this engraving shows an old yet very close approach to the present form of the monkey wrench. The engraving was taken from "Bergeron's Manuel du Tourneur—a Paris 1816."

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NEW YORK, JUNE 6, 1895.

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The Standard Angle for Lathe Centers.

The angle of 60 degrees has been now quite generally adopted for lathe centers—at least in all shops in which civilization has sufficiently advanced to cause the matter of standards to receive any attention whatever. This applies, however, to the smaller lathes only, say up to 30 inches swing, a quite prevalent notion being that for larger lathes in which heavier work is done 60-degree centers are too sharp, and that centers of greater angle—70 degrees, 75 degrees, 80 degrees and up to 90 degrees being advocated for such work as driving wheel lathes—are better.

There was a time, and not so very long since, when 60 degrees was generally regarded as too sharp an angle for any lathe, and that angle has fought its way into use by the constant demonstration that it is as strong as any greater angle, gives a better bearing, and is in every way better, especially if standard arbors and other tools manufactured for the market are to be used, all of which have standard 60-degree centers in them.

And as to larger lathes we are inclined to think that the practice of making centers greater than 60-degree angle is founded upon simply a notion, for which there is no reasonable basis, and that 60 degrees for such work is, all things considered, better than any greater angle.

So far as comparative strength is concerned, let us consider the case of driving-wheel axles for locomotives—the work for which the blunt center advocates are perhaps most certain that they are correct. In a driving wheel axle there is practically no limit to the depth to which the centers can go, and supposing the centering tool to be sunk into the work until the same diameter of center at the end of the axle is reamed in each case, it must be evident that the diameter, and, therefore, the cross-section of the lathe center at the end of the axle is the same, no matter what the angle of the center may be; and that a 60-degree center is, therefore, indisputably just as strong at this point as any greater angle would make it, while outside the axle the rapid increase in size of any of the proposed or used forms makes it unnecessary to consider their relative strength, that is to say, they are all stronger the further we go from the end of the axle up to the point of maximum diameter.

Granting this much, which seems self-evident, it is then about equally clear that the 60-degree center gives more bearing surface for a given diameter of center, and also that that surface is more nearly normal to the stresses caused by the weight of the work and by the cut, which is an important consideration.

Taking the matter of weight, for instance, a center having 90-degrees angle would act similarly to a wedge or inclined plane placed at 45 degrees and, neglecting friction, the force tending to drive the centers back or force them out of the work would be just equal to the weight upon them.

With a 60-degree center this force would be as 1 to .577, or only a little over half as great for the same weight, and the intensity of pressure upon the surfaces of the center and countersink would be much less so far as pressure due to weight or to the cut is concerned. But when we consider the pressure due to forcing up the tail center harder than is necessary to bring the centers into fair contact, it will, of course, be greater for the lesser angles, and a man running a wheel lathe, and accustomed to blunt centers and to forcing the tail center as hard as his strength will allow, will find if he uses a 60-degree center that the same strength exerted upon the tail-stock hand wheel may cause trouble, but the same exertion of strength will be entirely unnecessary, for the work will be better and more securely held by a more moderate pressure upon the centers.

We feel quite certain that a 60-degree angle for lathe centers is better for any lathe and for any work, however heavy, than centers of greater angle, and think that many wheel-lathe men and others who are so certain that 60-degree centers will not do for their work would find that they would do better than the various blunter centers that they now use, if tried fairly and not forced up with all the strength that can be brought to bear upon them, and there certainly would be many advantages in the universal adoption of the 60-degree angle for all lathes and for all centered work.

An Example in Dishonesty.

The other day we heard of a manufacturing concern which took summary action against an employe who used a small amount of material and time in constructing a tool for his own use, without the knowledge of his foreman—a tool which would have paid its cost in a short time, it is true, but yet which should have been made for and owned by the company at whose cost it was constructed. The man who made it was denounced as dishonest and lost his situation.

The incident reminds us of another occurrence in the same factory. An inventor appeared with a rude model of an improvement upon the machine built by this concern. He had been using one of these machines, had encountered some difficulties with it and, instead of writing complaining letters about it, had set to work to remedy the difficulty. He had not patented his invention, but came on to submit it to the judgment of the factory experts, his proposition being to take out patents upon it and allow this manufacturing concern its exclusive use for a reasonable—even a small—royalty. This inventor, in his innocence, supposed that, as he was dealing with wealthy, prominent and respected men, there would be no unfair treatment of him.

Their experts looked the matter over, and the inventor was requested to call again in a few days, which he did, and was then shown a model embodying the same ideas which he had conceived, which model was taken down from a high shelf in his presence, the accumulated dust of years blown off it and handed to him as evidence that his invention had been long ago conceived, tried and discarded.

The facts were, however, that this model had been hurriedly constructed in the interval between the inventor's first and second visits, and the dust had been artificially deposited upon it. The man who made it and who knew at the time that he was doing something to assist in a fraudulent, dishonest and contemptible trick happens to be the one now condemned and discharged for dishonesty.

Of course we believe that all employes should be honest and faithful, but we believe that other people should be as well, and we are confident that one of the strongest temptations to dishonesty by an employe is the knowledge that his employer is himself not "square," though this is, of course, no justification of dishonesty, and is not a temptation that is presented in a very large proportion of manufacturing establishments, we are happy to be able to say.

Control Should Equal Responsibility.

It would surprise very many men who are more or less discontented in the positions they now hold, and wish they were in others, to know how many other men, some of them in what seem to be much more desirable positions, are also dissatisfied, or at least find some features of their surroundings that are not as they would like to have them.

One who goes about much among machine shops finds very many men occupying responsible and apparently very desirable positions who for various reasons are looking for other places.

Among all the various causes for dissatisfaction there is no single one that compares in potency with the somewhat curious fact that men are too often hired and paid to do certain work the responsibility for which is laid upon them and yet are so much and so unnecessarily hampered and interfered with in the discharge of their duties as to make it impossible for them to properly do that work. In other words, it is too often forgotten that responsibility cannot, in the nature of things, properly go a hair's breadth beyond the field of control of him whose responsibility it is proposed to define.

This seems a self-evident proposition, and it is a well understood principle so far as the professions of medicine and of law are concerned. A man in his right mind who should employ a lawyer and then disregard his advice and go according to his own notions would hardly expect to hold his lawyer responsible for defeat, and it is well understood that a single point of deviation from a physician's orders correspondingly absolves him from responsibility.

It should, so it seems, be clear that the same principles apply to all positions of responsibility; and a man who employs an engineer, a superintendent or a foreman certainly should avoid arranging things so that the hardest part of his employe's work is the management of his employer instead of the management of the works or department he is supposed to direct, and for which he is supposed to be responsible.

An engineer who found himself in the employ of a shop proprietor, a man of considerable ability in his own line and a very likable gentleman on the whole, though having this one fault manifested by a disposition to interfere and to argue questions of shop management and of engineering, about which in the nature of things he could know nothing and which he paid the engineer for knowing, finally purchased some few elementary but good books treating of some of the simpler general principles of mechanics and engineering, gave them to this employer and asked him to study them, telling him frankly at the same time that there was little prospect of getting along smoothly until some educational work had been done. The result in this particular instance was good, mainly because the employer was not pig-headed—had the instincts of a gentleman and was capable of learning things and using his knowledge of them. In many cases such a course would be worse than useless, simply because such a smattering of engineering knowledge as would be obtained in that way would simply result in a swelled head and cause still more of wasted argument and unnecessary interference. Every case must, of course, be dealt with according to its requirements, but every man should be responsible for something, and whatever he is responsible for he should control. A man unfit to be trusted with control should be replaced by a fit man, one on whom full responsibility can safely be placed; and that man when secured can do justice to himself and to his employer only by insisting that full control be given him exactly up to the line of his responsibility.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(228) W. O. S., New York, writes: Kindly give me the address of the manufacturers of the "Dow" steam turbines. *A.*—Dow Steam Pump Works, 114 Beale street, San Francisco, Cal.

(229) W. H., Providence, R. I., asks: Which is the best way to leave a boiler when the plant is to be shut down? Should it be left full of water, or should it be left empty? *A.*—See answer to Question 216, in our issue of May 23d, current volume.

(230) W. S. G., ——, writes: Will you kindly inform me if it is the custom generally in the pattern shops throughout this country to make any allowance on patterns for the tapping they receive when the molder is about to draw them from the sand, and if such is the custom, what the allowance and the terms used to express it are? *A.*—Such allowance is not usually made, though in some cases where patterns are

small, it is found that the rapping just about compensates for the shrinkage, and the patterns are therefore made to the size the casting is intended to be. This allowance is, however, usually made as a result of experience with the particular job in hand, and we believe it is not customary to make allowance for rapping except where such allowance has been found by trial to be necessary, and the necessity for it will depend upon the conditions for each job.

(231) C. C. S., South Bethlehem, Pa., writes: Please give me a recipe for cleaning rust off drawing instruments and brightening them up. *A.*—Use very fine emery cloth. 2. Have you ever printed in your columns an outline of what books constitute a library for a mechanical engineer? *A.*—No; in fact it is not an easy matter to give a list satisfactory to all. Mechanical engineers generally buy books on such subjects as come up or liable to come up in the special branch of engineering in which they are engaged. We have known engineers whose libraries did not cost over 200 or 300 dollars, and we also know of one who has spent very nearly 1,000 dollars, and is still collecting books. 3. Where can I get a copy of the "Transactions of the American Society of Mechanical Engineers?" *A.*—Write to Prof. F. R Hutton, 12 West Thirty-first street, New York.

(232) X. Y. Z., New Brunswick, N. J., asks: What would be a good style of plunger for a duplex boiler-feed pump, the water cylinder is 4 inches diameter, and 8 inches stroke? Our water is sometimes somewhat muddy, and we have much trouble with the solid plunger now in use. *A.*—We do not see how the solid plunger can be improved in form. For overcoming the trouble to some extent, we can suggest only to make the stuffing box longer, and in it use a good quality of flexible packing. But this is not the proper way of overcoming your trouble, for it is bad and dangerous practice to pump muddy water into the boiler. The best way is to purify the water by means of filtering through an apparatus, of which there are several kinds on the market, and thereby prevent injury to the boiler and pump. 2. What materials are generally used for filtering purposes in an oil filter, and what is the thickness of the material? *A.*—You will find a description of an oil filter, which is said to give very satisfactory results, on page 151, current volume.

(233) C. W. E., Pittsburg, Pa., writes: Please inform me how to find the pressure on the crown sheet, tubes and shell of a boiler during foaming. *A.*—The pressure on these parts of a boiler is found in precisely the same way as adopted for finding these pressures under ordinary circumstances. The steam gauge shows the pressure in pounds per square inch, consequently the area of the crown sheet in square inches multiplied by the pressure indicated by the steam gauge, gives the total pressure in pounds on the crown sheet. Multiply the outer radius in inches of the tube by the steam pressure indicated by the gauge, the result will be the crushing pressure per inch of metal lengthwise on one side of the tube. If the steam is inside of the tube, then multiply the inner radius by the steam pressure, the result will be the pressure in pounds per inch of metal lengthwise on one side of the tube tending to burst the tube. In the same way the bursting pressure on one side of the shell is found, namely, multiply the inner radius of the shell by the steam pressure as indicated by the gauge, the result will be the bursting pressure in pounds per inch of metal measured lengthwise of the boiler.

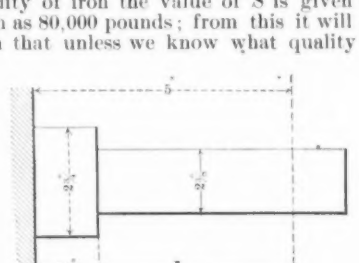
(234) W. A. F., Appleton, Wis., writes: We have a boiler house in which there are eight water-tube boilers. We use screenings and shavings for fuel. The shavings are blown over by an exhaust fan located in the mill. The screenings make quite a lot of ashes which require wheeling out quite frequently, necessitating a frequent opening of the ash pit doors; this seems to admit cold air and causes a fog which reaches the hight of the boilers and extends throughout the boiler house; it is so bad sometimes of a cold day that we cannot see a hand before us. When it was first noticed, we put on storm doors and placed a fan near the top of the roof with a large cupola above it. This did not help us much, it took the fog out of the space above the boilers only. We have also tried a long wooden draught box from the middle of the boiler house up to the exhaust fan. Now, I propose to try several other ways: First, put in storm windows; second, burn coal instead of screenings, this will reduce the quantity of ashes; third, extend a pipe to both ends of the boiler house for carrying the fog to the fan; fourth, erect several coils of steam pipe around the boiler house and heat up the lower part. Any suggestion you can make will be appreciated. *A.*—The several methods suggested by you will not help you. It is difficult to make any suggestion without examining the plant. We are, however, inclined to believe that your chimney draught is very poor; if this is increased, your trouble may cease. The best way will be to call in a mechanical engineer to find out the cause of the trouble and suggest a remedy. It is also possible that Allington & Curtis, Saginaw, Mich., manufacturers of suction and blast apparatus, may have a suitable device for overcoming the trouble. Of course, the use of coal instead of screenings will reduce the ashes, but if the chimney draught is faulty there will be trouble in burning the coal.

(235) M. L., Brooklyn, N. Y., writes: Suppose a steamship is running at full speed, the engines are running at a rate of 90 revolutions per minute, one ton of coal is burnt per hour. Now, assume that this steamer is towing another vessel, the speed of the engines of the steamer is now 60 revolutions per minute, with the throttle valve wide open as before; will the steamer burn the same quantity of coal per hour under both conditions? *A.*—To answer this question many elements will have to be taken into account, some of which will involve assumptions of doubtful accuracy, so that the result of the computation may not be satisfactory. It is quite possible that when the ship is towing another vessel, the engine may develop a greater horse-power, under these conditions a greater quantity of coal will be burnt per hour. If it should happen that an indicator card, taken when the engine is running at 90 revolutions per minute, is exactly like one taken when the engine is running at 60 revolutions per minute, then we might expect that the quantity of coal burnt per hour when the engine is running at the high speed will be about 50 per cent. greater than when running at the slow speed. The best way for obtaining reliable information is to measure the coal under both conditions of running, and then keep the data for future reference. 2. The consumption of coal in four boilers in a steamship is one ton per hour. Now, suppose we take one boiler out of service, will the remaining three boilers burn the same quantity of coal as was used in the four boilers for the same quantity of steam furnished to the engine in a given time? In other words, is it more economical to use four, instead of three boilers? *A.*—It is more economical to use the four boilers, because on steamships the boiler capacity is cut down to the lowest point consistent with economy, and any further reduction in capacity will necessitate running the remaining boilers beyond their capacity which always involves more or less loss in fuel. Your third question is too indefinite to answer.

(236) L. A., Attleboro, Mass., writes: I have a shaft as per sketch. The shaft is $2\frac{3}{4}$ inches diameter through a distance of $1\frac{1}{2}$ inches, and $2\frac{7}{8}$ inches in diameter throughout the rest of the length. Please give me a method for computing the load which will break this shaft, the load being applied at 5 inches from the shoulder. *A.*—The weight which will break this pin can be found approximately by the following formula:

$$W = \frac{S \times d^3}{6 \times l} \times .589,$$

in which W = weight or load in pounds, S = breaking stress on the outer fibers of material, d = diameter of the pin in inches, and l = the distance from the support to the point of application of the load. The value of S depends much on the quality of the iron, some authorities give an average value of 55,000 pounds for S, and for a good quality of iron the value of S is given as high as 80,000 pounds; from this it will be seen that unless we know what quality of



iron is used, the result may not be very exact. We will adopt 55,000 pounds for S; $l = 5$ inches, and $d = 2.75$ inches; then substituting these values for the corresponding letters in the formula we have,

$$W = \frac{55{,}000 \times 2.75^3}{6 \times 5} \times .589$$

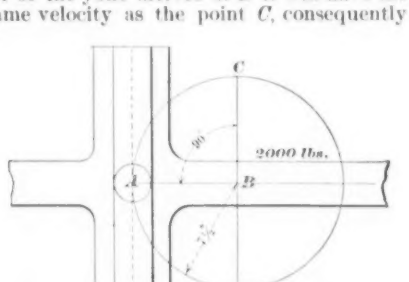
$= 2{,}245.6$ pounds for the load to break the pin at a distance L from the point of application of the load. The breaking load at a distance l from the point of application is found by the same formula, remembering that l is now equal to $3\frac{1}{2}$ inches, and $d = 2\frac{7}{8}$ inches. From this we get,

$$W = \frac{55{,}000 \times 2.375^3}{6 \times 3.5} \times .589$$

$= 20{,}665$ pounds, which shows that the weakest point is at a distance l from the point of application of the load.

(237) J. S., Buffalo, Wis., writes: Kindly give the theory or philosophy of the leaking of tubes in vertical boilers where a portion of the tube is not submerged. Does the trouble arise from expansion in length or increase in diameter of the tube? What is the best method to overcome this trouble where it is not desirable to throw out the boiler? *A.*—The expansion in the length of the tube tends to cause leakage at the ends; the increase of the diameter of the tube, we believe, will scarcely have any injurious effect. The principal cause for the leakage at the upper ends of tubes in vertical boilers is that the ends of the tubes waste away by being continually heated, and in time will often prove very troublesome. Much of this is due, perhaps, to the too rapid firing before steam is in the boiler. The remedy is obvious, fire slowly in starting, and after steam has been raised do not drive the boiler beyond the capacity for which it was designed. Of course this will not stop the leakage completely for all times, but will reduce the frequency of the occurrence. We should also place wrought-iron ferrules on the outside of the upper ends of the tubes; for this purpose the upper end of each tube should be tapered through about one inch of its length; the ordinary way of forming this taper is to hold the tube in an upright position, and allow it to drop a few times into a die bored out to the proper taper. The outside of the ferrule should be turned cylindrical, and the inside bored out tapered to fit the taper on the tube. The depth of the ferrule should be about $\frac{1}{4}$ inch greater than the thickness of the sheet; the greatest thickness of the ferrule should be about $\frac{1}{2}$ inch at one end, the taper bringing the opposite end to a knife edge. When these ferrules are used the holes in the tube sheet should be drilled $\frac{1}{32}$ inch larger in diameter than that of the tubes; this will be an advantage when the tubes have to be taken out for repairs. The ferrule and the tube must be expanded together. 2. Which is the best expander to use in the above case, a roller expander or a sectional one? *A.*—We prefer the roller expander, with this tool the tubes can be expanded without striking a blow on them, thus rendering the tubes far less liable to crack, and leaky ones can be tightened, with steamon the boiler, with perfect safety. Roller expanders are no more liable to break than the sectional expander, and are easily kept in order, as the rollers are the only things that can give out, and they can be replaced in a few moments.

(238) J. W. D., Brooklyn, N. Y., writes: Below is a sketch of a problem of which please give a solution. The crank is $7\frac{1}{2}$ inches long, and makes $1\frac{1}{2}$ revolutions per second; the pin moves a yoke in a horizontal direction, whose weight is 2,000 pounds; what force will be required to move this weight from A to B? The crank pin has a uniform velocity. *A.*—When the center of the yoke arrives at B it will have the same velocity as the point C, consequently



its momentum will be equal to the product obtained by multiplying the mass by the velocity in feet per second. The mass is obtained by dividing the weight by 32.2, which is the acceleration of gravity. The momentum is equal to the impulse, which is found by multiplying the force in pounds by the time in seconds during which the force acts. The whole of this is clearer shown by symbols. Let f = force in pounds, t = time in seconds during which the force acts, m = mass of the body or yoke, and v = velocity in feet per second at B. Hence from the above we have

$$f \times t = m \times v. \qquad (1)$$

The velocity v is equal to

$$\frac{2 \times 7\frac{1}{2} \times 3\ 1416 \times 1.5}{2} = 5.89 \text{ feet}$$

per second. The mass m is equal to $\frac{2{,}000}{32.2}$ $= 62.111$, and the time t during which the force acts in moving the yoke from A to B is equal to $\frac{1}{6}$ of a second. Substituting these values for the corresponding letters in formula (1) we have

$$f \times \tfrac{1}{6} = 62.111 \times 5.89,$$

from which we get

$$f = \frac{62.111 \times 5.89}{\frac{1}{6}} = 2{,}194.98 \text{ pounds for}$$

the required constant force acting in the direction from A to B. Since we do not know what kind of bearings are used we have neglected the friction. We do not have on hand the edition of the work to which you refer. Kindly give us the meaning of symbols, and we will explain the given formulæ.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 452.

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"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

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Some Thoughts on Machine Design—I.

BY PROF. DE VOLSON WOOD.

Nearly all works which treat of "Machine Design" deal almost exclusively with the strength of the parts. They might more properly be entitled "the mathematical proportions of machines." This is a vital part in the designing of machines, but in very many cases it is the least important. In the process of designing, it is often necessary to have some knowledge of the patternmaker's "art," of the "foundryman's "art," of the machinist's "art," and a knowledge of materials so as to select those best suited to the particular machine. Malleable iron and steel castings to-day may be substituted for forgings of former times. The designer should exercise good taste in regard to forms that they be not offensive to the eye. There is usually but little chance to make a useful machine especially attractive by its form, for the main outlines are largely determined by the work it is to do and its environment. The arrangement of the parts so that they will be convenient for use in managing the machine, should also receive his attention. Many important things cannot be expressed by algebraic formulæ, nor thoroughly taught by books, but depend chiefly on the judgment, skill, and the æsthetical tastes of the designer. These faculties may, however, like all others, be educated by reading, study and exercises.

The principles of machine design involve, then, at least three distinct branches of knowledge:

1. Formulated science.

2. Art, involving knowledge peculiar to the trade and which cannot be safely expressed in definite, arbitrary rules.

3. Commercial, involving æsthetics, proper materials, and demands of trade.

An expert designer does not classify his knowledge in this or any other manner;

still, in writing upon the subject or in acquiring knowledge there is an advantage in classification.

To illustrate the process and principles which are involved, we take some special examples and show, not how an expert does proceed, but how one may be conceived to proceed as he is learning the "art." First consider

THE CYLINDER.

There are many kinds of cylinders, as the steam cylinder, pump cylinder, hydraulic cylinder, water-main cylinder, the gun barrel as a cylinder, etc., each of which has peculiarities of its own. We begin with the steam cylinder. First, to find its thickness assume it to be a simple cylinder of indefinite length without flanges or stays, the diameter being $A\ B$ and subjected to an internal pressure of p pounds per square inch. The pressure will be directly against the concave surface of the cylinder, and will tend to force one-half of it directly away from the other half. Conceive a plane $A\ B$, Fig. 2, passed through the axis, and consider one inch in length of the cylinder. Now, the forces each equal to p may be conceived as acting directly against the diameter. These forces will tend to force the two halves apart, just the same as those acting on the concave surface. Let this pressure be resisted by a pull of T pounds at A and another of the same amount at B; these will be the same as the pull in the metal in an actual cylinder, and each will equal the push on the radius $A\ C$. Since the piece we are considering is one inch long, we will have:

T = 1 inch × radius × pressure per square inch, or

$$T = p\ r \qquad (1)$$

Having the force T, we may easily find the thickness necessary to resist it. Steam cylinders are made of cast-iron, and it requires a pull of 18,000 to 20,000 pounds to the square inch to break such cast-iron as is used in good castings, but as it is not intended that such cylinders shall burst by the pressure to which they will be subjected, so large a value should not be used; and hence a fractional part of 20,000 will be used. If the pressure is intended to be 60 pounds to the square inch, it might, accidentally or otherwise, be subjected to a much greater pressure; either by a rise in the steam pressure, or by water in the cylinder; also the casting might not be as strong as the "test piece." The cylinder is an important part of an engine, and the cost of the cast-iron is small, compared with the work put upon it, and the cost of a breakage, due to a weakness in the iron, would far exceed the saving in the iron, so that in practice it is considered advisable to use a comparatively small fraction of the strength, say, $\frac{1}{5}$ or $\frac{1}{10}$. We will use $\frac{1}{5}$ of 20,000 or 2,500 pounds per square inch. Hence if the thickness be multiplied by 2,500, we will have the safe strength for each inch of length; hence by formula (1) the push $p\ r$ = the pull T = 2,500 × thickness, or

$$p\ r = 2{,}500\ t$$

$$\therefore\ t = \frac{p\ r}{2{,}500} \qquad (2)$$

Example 1.—If the steam pressure be 90 pounds, and the diameter of the cylinder 4 inches, what should be the thickness of the cylinder?

According to formula (2), we have, the radius being 2 inches,

$$t = \frac{90 \times 2}{2{,}500} = 0.072 \text{ of an inch,}$$

or less than $\frac{1}{12}$ of an inch.

Example 2.—If the steam pressure be 180 pounds, and diameter of cylinder be 28 inches, what should be the thickness of the cylinder?

According to formula (2) we have,

$$t = \frac{180 \times 14}{2{,}500} = 1.00 \text{ inch.}$$

The answer to the first question, $\frac{1}{12}$ of an inch, is too small, so we will consider other elements. We consult the molder. He says it is impractical to make so thin a casting. As it is to be bored out, he can make a core sufficiently small so that he can make a sound casting, but he would be obliged to set the mold very perfectly, or the machinist might bore a hole in one side or the other, and a small blow hole might ruin the casting—make it at least $\frac{1}{4}$ of an inch; and if the cylinder is to be 4 inches diameter, as in the example, make it $\frac{1}{2}$ of an inch, or so. We consult the machinist, and he assures us that it is not practical to make a cylinder 4 inches diameter $\frac{1}{12}$ of an inch thick for commercial purposes; also in the processes of manufacture, an accidental blow from a tool might ruin it; and sometimes cylinders are rebored, and material or "stock" should be provided for such a contingency and he advises that it be at least $\frac{3}{8}$ of an inch thick if not $\frac{1}{2}$ an inch. Others say that no steam cylinder should be less than $\frac{1}{4}$ inch thick. Here, then, experience and judgment are required in order to assign a proper value. Persons in the different "arts" would assign different values; and there is no law for such cases that permits of a definite formula. It may, however, be expressed in the form of an equation, thus,

$$t = \frac{p\ r}{2{,}500} + c \qquad (3)$$

in which c may be called the "constant of circumstances," or "modulus of circumstances," the value of which is to be assigned by the designer for each particular case.

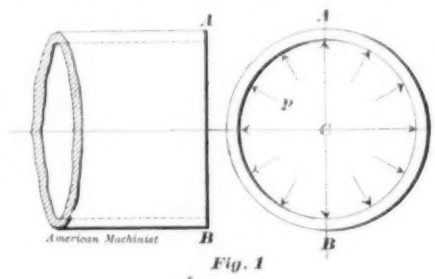


Fig. 1

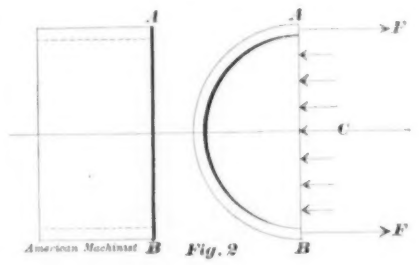


Fig. 2

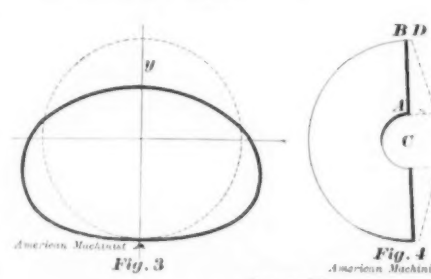


Fig. 3 Fig. 4

Some writers have attempted to give a definite value to this constant. Thus,

Van Buren, $t = 0.0001\ d\ p + 0.15\ \sqrt{d}$.

Also $t = 0.03\ \sqrt{d\ p}$.

Tredgold, $t = \frac{(d + 25)\ p}{19{,}000}$.

Weisbach, $t = 0.00033\ p\ d + 0.8$.

In the AMERICAN MACHINIST for July 26, 1894, Wm. Kent gives a discussion of many formulæ.

But these give absurd results in many cases. Thus Weisbach's formula requires that the thickness shall always exceed 0.8 of an inch, but very many cylinders only $\frac{3}{8}$ of an inch thick are working, and have been working for years with satisfactory results. Direct-acting pumping engines of considerable size, rock drills, and cylinders of steam engines several inches in diameter have done good service, in which the thickness of the shell did not exceed $\frac{1}{2}$ inch.

The strength of steam cylinders is increased by the flanges at the ends, although these are for another purpose and are not necessary for bursting strength.

It will thus be seen that the bursting pressure is of the least consequence in proportioning the thickness of small steam cylinders; that when thick enough to answer the requirements of other considerations there is no danger of their bursting in ordinary practice.

In the second example the thickness was found to be 1 inch, which is sufficiently thick to resist bursting, even if the pressure be 250 pounds, but for reasons given above something should be added to this for the "modulus of circumstances," making it $1\frac{1}{4}$ or $1\frac{1}{2}$ inches thick.

Example 3.—In the Atlantic liner "Paris," the low-pressure cylinder is 110 inches diameter, and the highest steam pressure about 20 pounds, what should be the thickness of the shell?

According to formula (2) we have

$$t = \frac{p\ r}{2{,}500} = \frac{20 \text{ pounds} \times 55 \text{ inches}}{2{,}500} =$$

0.44 of an inch nearly, or about $\frac{7}{16}$ of an inch.

The practical mechanic will say at once that this is "too thin" for such a large cylinder, especially if it has much length. The stroke of the piston in that engine is 5 feet, so that the length of the cylinder is probably about $5\frac{1}{2}$ feet between the flanges. A thin, long, large cylinder is liable to distortion from its weight, so that if it were bored out perfectly cylindrical in a vertical position it would be flattened to an oval if placed horizontally, like the annexed Fig. 3, only this is distorted. According to an analysis of the writer the vertical diameter of an elastic ring (or cylinder) will be shortened by its own weight, when resting on its side, an amount

$$y = 0.4674\ \frac{w\ r^4}{E\ I} \text{ inches.}$$

"Trans. Am. Soc. Mech. Eng.," Vol. XII., page 917, Equation (34). In this,

w = weight of unity of length of the ring, so that if the ring be 1 inch long, and t inches thick, and the weight of cast-iron 0.26 of a pound per cubic inch, then $w = 0.26\ t$.

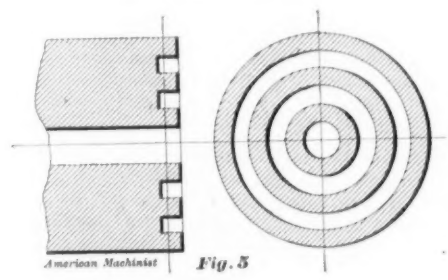


Fig. 5

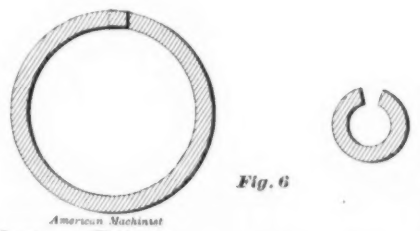


Fig. 6

I = the moment of inertia, which will be $\frac{1}{12}\ t^3$.

E = 20,000,000 pounds, the coefficient of elasticity, and

r = the radius of the ring;

then we have

$$y = 0.0000000718\ \frac{r^4}{t^2}. \qquad (4)$$

If r = 55 inches, as in the cylinder of the "Paris," and if t is 0.44 of an inch, then

$$y = 1.47 \text{ inches,}$$

or the vertical diameter would be shortened nearly $1\frac{1}{2}$ inches by resting on its side. If the thickness were 2 inches, the vertical diameter would be shortened

$$y = 0.162 \text{ inch,}$$

or about $\frac{1}{6}$ of an inch by resting on its side, and the horizontal diameter will be elongated so as to exceed 110 inches, so that a piston truly cylindrical will not fit it. Large, long cylinders ought to be bored in the position they are to be used, but if sufficiently thick the distortion will be small from change of position.

While 0.44 of an inch is sufficiently thick to resist bursting with a 20-pound pressure allowance should be made for a greater pressure. Triple-expansion engines are sometimes run as compound engines if the intermediate cylinder is disabled, in which case it might be subjected to, say, 80 pounds pressure, requiring a thickness of

$$t = \frac{80 \times 55}{2{,}500} = 1.36 \text{ inches,}$$

or about $1\frac{3}{8}$ inches thick, and $1\frac{1}{2}$ inches might probably be thick enough to satisfy all requirements; while some designers would make such a cylinder $1\frac{1}{4}$ inches thick, others $1\frac{3}{4}$, and still others 2 inches.

Formula (3) is also applicable to cast-iron pipes for water mains, steam pipes, etc.

If the material be steel or wrought-iron under ordinary pressures, formula (2) will give an excess of thickness, and yet the process of manufacture for commercial purposes is such as to require a greater thickness than that given by the formula, so that here "the art of the trade" has a controlling influence in determining the thickness, and science simply shows that the thickness so determined gives abundant safety.

If the internal pressure be very great, as in hydraulic presses, another law comes in. For experimental purposes, pressures of 13,000 and even 20,000 atmospheres have been used. These are equivalent to 191,000 and 290,000 pounds respectively to the square inch, forces sufficient to pull asunder the strongest steel bar, or even steel wire. In these cases the cylinder must be very thick. The resistance over the section $A\ B$ will not be uniform, the greatest stress being at the base at A and the least at B, the rupture beginning at A and extending outward, the stress varying according to some law of the inverse distance from the center C, being less and less from the inside at A to the outside at B. It is not easy in this case to determine the total resistance of the shell to bursting; but if the material be perfectly elastic and perfectly homogeneous, it is found mathematically that the

$$\text{thickness} = t = \left[\sqrt{\frac{T + p_1}{T - p_1}} - 1\right] r_1 \qquad (5)$$

in which T is the tenacity of the material as found by experiment, p_1 the internal pressure per square inch, and r_1 the internal radius.

Example.—If the tenacity of steel be 150,000 pounds per square inch, the internal radius 2 inches, what must be the thickness of the shell to resist 130,000 pounds to the square inch internal pressure?

Here T = 150,000, p_1 = 130,000; hence

$$t = \left(\sqrt{\frac{280{,}000}{20{,}000}} - 1\right) 2 = 2\left(\sqrt{14} - 1\right) = 5\tfrac{1}{2}$$

inches nearly. If the internal radius were 1 inch the thickness would be $2\frac{3}{4}$ inches.

It will be seen from formula (5) that if the internal pressure p_1 equals the tenacity T, the thickness must be infinite or, in other words, the cylinder cannot be thick enough to resist bursting.

When cylinders are to be subjected to very great internal pressure, they are manufactured in such a way as to increase their resisting power. Thus in the manufacture of the celebrated Rodman cast-iron cannon, the inside or bore was cooled first by causing a stream of water to run through pipes placed in the bore; then as the parts more remote from the bore cooled they shrunk onto the cooled parts and compressed them, so that when the whole casting was cooled the iron next to the bore was in a state of compression, and the first effect in firing a charge—or otherwise producing an internal pressure—was to relieve the stress, and no *tension* would be produced until the material was so stretched as to remove all the compression, and before it would burst the internal pressure must produce a stress equal to the compressive force and the tensile strength combined. The outer portions would be subjected to tension, so that before bursting the whole transverse section would be more nearly under a uniform tensile stress. To show that there was compression and tension produced by the cooling process and their amounts, annular grooves were cut in the end of the cylinder shown by the white anulii in Fig. 5, and the rings then cut off. By cutting these in two the inner ones would open and the outside ones spring together and close up the cut (Fig. 6.) and it might be that the ends would pass each other if permitted to do so. The same principle has been applied to the manufacture of steel cylinders for steel guns. Staves of crucible steel, closely fitting, are used to surround the bore, and give longitudinal strength, onto

SOME THOUGHTS ON MACHINE DESIGN.

which are shrunk steel cylindrical rings, thus compressing the staves closely together Outside these rings are shrunk other steel rings, and so on, thus subjecting the inner rings to compression, while the outer ones would be subjected to tension. If the steel rings have a tensile strength of 140,000 pounds to the square inch, and were compressed by the process of manufacture 120,000 pounds, it would require an internal pressure sufficient to produce 260,000 pounds tension before it would burst. This principle has been used to strengthen cast-iron guns, as in the Parrot gun, which had a heavy iron band two feet or so long shrunk onto the breech.

The steel staves might be wound with steel wire, as has been done, forming a very strong gun, and comparatively light. With our present knowledge of the strength of such cylinders, formulæ are of little, if any, value. Much science is involved, and more science and art are developed with every stage in the construction of such cylinders, and constitute the "art of that trade."

Grinding with Emery and Corundum Wheels.—II.

BY C. H. NORTON.

A machine tool builder ordered of a well-known emery wheel company a special wheel, and named the following conditions: "We shall insist upon good cutting qualities, durability and absolute safety; speed 2,000 revolutions." When we realize that greatest durability and greatest rapidity of cut cannot exist in the same wheel, and that the speed should bear a relation to the grade, width of cut, size of grain, and that all these must depend upon the nature of the work, we can see the lack of thought in giving this order. One could go on enumerating such cases, their name is legion.

It is a strange fact in human nature that most men refuse to give due weight to the opinion of others who have "been there," but assume to see so clearly that the "been theres" are mistaken. It seems strange when men see others successful in using a certain machine, that when they come to use the same machine they should throw it out as worthless; yet men will do that thing. They will visit another shop, see others using emery wheels successfully on certain work, take one of those wheels home with them, use it on the same work and machine, then decide that the wheel is simply worthless, throw it aside, and never seem to suspect that they themselves may be at fault.

There are others who never consider one word of instruction or advice given about emery wheels, but assume that "an emery wheel is simply a round wheel made of emery," and that to make all that talk about so foolishly simple a thing is nonsense; so they buy the cheapest wheel and the one that will last the longest, then light a cigar and muse on the saving they have made in buying that lot of wheels, while any one of them would know better than to buy a horse or a suit of clothes on that principle. One cause of so much misunderstanding, misbuying and misuse of emery wheels is the notion that the emery wheel is so simple, while the fact is that the selection and use of emery wheels is an art that is in its infancy. Enough has been developed to show great possibilities before us in the realm of grinding wheels and machines for their use. In my opinion, even those who have been nearest to the grinding art hardly conceive of the possibilities before us as we gradually wear away our prejudice.

I think no one who has been permitted to study the grinding problem for any considerable length of time, where they have had contact with great varieties of work that must show both profit and accuracy, can doubt for one moment that by the use of cutting particles made into cutting wheels in the multitude of forms, mixtures, grades and combinations opening up to us every year, we have possibilities that the warmest advocate of the good old natural stone never dreamed of, and that, should one undertake to do much of the work now done with emery wheels with grindstones, because someone says that "in England they use grindstones in every place where we use emery wheels," he would find it simply impossible to compete, and in very many cases impossible to do the work at all, regardless of the excellent authority from which the statement comes. In this connection it is but fair to say that in England they *manufacture* grindstones in order to get variety of grades for variety of work. These stones have been carefully tried on this side of the water, but, while they are better than the natural stone inasmuch as they can be selected to suit the work, yet they did not compete in any sense with the wheels made of corundum and emery. After a number of years contact with grinding matters I cannot conceive why anyone should discard a good emery wheel for a grindstone of any quality.

And now we come to the question, what is a good emery or corundum wheel? and in answering that let us fix in our minds that *grinding* not polishing wheels are under consideration.

The answer to that question to be understood involves a knowledge of wheels from more than one line of experience, but summed up briefly a good wheel is, first of all, one that is made up *entirely* of *cutting* materials, no glue, no rubber, no varnish, no celluloid. The gum wheels have a very useful place. I will speak of it at another time, but it is not in the field now under consideration. Next, a good wheel is of the proper diameter, width of face, size of grain, the proper grade of hardness, the proper mixture of material and bonds, all emery, all corundum, or mixed, according to the work to be done. It should be run at a speed suitable for the size, width, grain, grade, and the work to be done, and should cut under the pressure made necessary by the above conditions. To get the best results from a really good wheel a very light pressure is necessary.

The question of speed of wheels is the great stumbling-block of all. There seems to be a general notion that there is some one surface speed suitable for all emery wheels, whereas nothing could be further from the real fact. I have been asked so many times, "What is the speed for an emery wheel?" In reply I might ask, what is the speed of lathes, regardless of shape, kind of work, material, etc.? Is it possible to table any figures that will be even approximately applicable to so wide a range of conditions? To use the lathe successfully, is it not necessary to have a fund of knowledge stored in the mind through experience, but that cannot be tabulated? The speed and grade of the wheels is subject to the law of every day experience and must be varied to suit an endless variety of circumstances, but no more so than the lathe. We never hear of anyone throwing out the engine lathe and returning to the good old hand lathe because hard material, run at too fast a speed, drew the temper from the lathe tool. Oh no, we have learned that the speed of the work, shape of tool, kind of material, shape of work, amount of feed, strength of lathe—all must be considered, yet who can condense this into a table or formula? I am aware that there are those who have such a mania for alphabetically arranged tables, lists and formulæ, that they attempt to tabulate such things, and then regard all workmen as rebellious who cannot understand and use them.

I will venture the prophecy that when emery-wheel grinding machinery has had the same place in the experience of mechanics as has the engine lathe, that relic of the past called a grindstone will remain only in shops where they still retain the old chain lathe and tobacco pipes as essential aids to skilled labor.

There seems to be a popular notion that a grinding wheel should run at as high a speed as possible and avoid rupture. Perhaps it should, but it depends upon the relation of size of grain and softness of texture to the work to be done. Speed of cut and amount of cut are quite different. We would not teach an operator to run a milling cutter as fast as it could be revolved, in order to remove the most stock in a given time. If we should leave him with the simple statement that the faster the cutter revolved the more work he would turn out, it would not be many moments before we should require a new cutter in most cases. Experience has taught us that depth of cut, rather than number of cuts, gives us the most work or longest life of edge in proportion to work done. It is obvious that the more rapidly the cutting particles of a wheel are forced across the metal the sooner will they become rounded and dulled, in which case they must be thrown away and new ones used, or heating and glazing will result in drawing the temper of the tool; at the same time grinding will become slower.

To increase the rapidity of grinding at any speed, it is necessary to soften the texture or grade of wheel in order that its particles may be more easily torn from their setting, and new ones exposed before they have become sufficiently dull to cause heat and retard grinding. If what has just been said is true, then a rapid running wheel requires either greater pressure, consequently heat and inaccuracy of work, or softer texture, consequently greater loss of emery. If we try, as so many do, to get rapidity of cut without heat and at the same time have a lasting wheel, we shall always fail if the wheel is revolved so rapidly as to dull the particles quickly. With the milling cutter we decrease the speed and increase the feed until the danger of breaking the teeth stops us, or, rather, we could if our milling machines and cutter arbors were anywhere near strong enough. Right here is where so many people fail in grinding operations; they seem to forget that the depth of the cut cannot be greater than the projections of the particles from their setting, unless the teeth or particles of the wheel are either worn away or held so strong in their setting as to remain a long time after they are dull, and perhaps until they are worn entirely away. We forget, I think, that in case we use the particles after the cut or scratch is gone, and the emery wheel smoothed off flat, the friction necessary to cause abrasion is very great.

I have found that a speed much slower than is common and a softer wheel than is common, enable one to grind a tool in much less time than on a grindstone, and that the pressure required to accomplish this rapid grinding is so light that not one man in a thousand can be induced to keep from pressing too hard, thereby wasting the wheel; yet I have found that if the tool is held sufficiently lightly, the wheel will last as long as the more rapid running wheel, that the saving in time is very noticeable, and that the tool remains cooler. Does the reader realize how very keen the cut of fresh corundum and emery is before it has been rounded by friction?

Could workmen and others overcome their prejudice enough to see, first, that emery and corundum particles are sharper and harder than sand, therefore will cut metals quicker and longer without losing their edge and with less pressure, therefore with less heat; next, that if they have wheels that will not do so it must be the fault either of those particular wheels or the way they are used; and then free the mind of every thought of polishing, but rather assume the wheel to be a grindstone and run it at the same speed if you please, give it the same ability to cast off its particles as they become dull; then on the same arbor, run under the same conditions, either the emery or corundum wheel will outwork the grindstone fourfold, and while the temperature of the tool will remain so low as to be placed against the flesh with safety when withdrawn from the emery wheel, when withdrawn from the grindstone it will burn the flesh.

If the reader entertains the popular notion that all emery wheels (because they are emery) draw the temper of tools, and by some mysterious magnetic, electrical or hypnotic influence peculiar to themselves, make an edge that will not cut long and well, I will ask him to try the experiment and "pursue it fearless of consequences" with an emery wheel whose combined grade and size of particles are such as to produce the same grain of cut upon the steel as does the grindstone with which it is to be compared, whose speed and ability to cast off dull particles is identical with the grindstone. Will he actually try this? Has it been tried? If so, it has been found that the edge is identical whether ground on grindstone or emery wheel. I said run it at the same speed; you may and still get good results; but the fact that its particles are harder than the sand particles makes it possible for us to run faster and yet get a deeper and cooler cut.

In the experiment just suggested, as the particles are practically the same size and rubbed away with the same friction, the sand particles becoming dull first will cause the grindstone to waste faster for the same amount of work. The fact is we are unfair in our trials; the stone and wheel are seldom, if ever, up to even a fair relation for such trials. Many wheels are very much harder than the stone, while the stone is *always harder* and *finer* than a *really good* emery wheel, and in the latter case you do not give the saving in time its rightful place in the problem. Another and very important point is that your workmen do not use the soft cutting wheel fairly. Just enough pressure will cause it to cut very rapidly without undue loss of wheel; more pressure will cause it not only to waste, but actually to cut slower. The difference in pressure required between a grindstone and a really good emery wheel is very great, yet, not one in a thousand realize this difference; thus it is that makers of tool grinders and wheels for them furnish you a wheel so hard that you can jam and push on it just as hard as you used to on the old grindstone, knowing that if they do not you will never buy another, because you will destroy it so soon as to affect your pocket-book. To enable you to grind more quickly on this hard wheel, they make it of coarser particles, and you bear on to this piece of unyielding and coarse granite, when, lo! away goes the temper, the edge is like saw teeth, you lose your temper, and with words as rough as saw teeth, you declare that an emery wheel will not make as good an edge as a grindstone, and in a fit of madness you tear the thing from its place, tumble it over on the scrap pile, return to the grindstone, light your cigar, and muse on the nonsense of modern inventions. But your thought has not embraced all the subject. While you are pushing against, and waiting for the good, old-fashioned grindstone to wear off the tools, another of a more patient frame of mind will calmly reap the reward of more careful investigation. For *really good tool grinders are now in use*, and are possible to all, when all acquire that knowledge of wheels that is stored in the mind through experience, but that cannot be tabulated.

The success of grinding depends as much upon the machine on which the wheels are used, as upon the wheels themselves. This is so often overlooked that wheels are blamed many times when they should not be. The question of grinding machinery is one that needs more study than the average shop manager has yet given to it.

A sad accident occurred in a printing and bookbinding establishment recently. A girl 14 years old attempted to pass a vertical shaft running within a foot of a partition. Her clothing was caught by the shaft, she was whirled rapidly around, her head was crushed, and she was instantly killed. She should not have attempted to pass between the shaft and the partition, but it should have been impossible for her to try it.

Figures recently published in "Geyer's American Paper Trade Directory" show that there are 1,313 paper mills, employing 50,757 employés and using an aggregate of 603,837 horse-power for driving them.

The pith from cornstalks is now thought to give promise of a satisfactory material for use in war ships to allow shot to pass through it, and then close to exclude water.

The A. S. M. E. at Detroit.

The secretary of the American Society of Mechanical Engineers has sent out the usual little blue book, containing the program of the coming meeting of the society at Detroit, June 25th to June 28th, inclusive. Circulars accompanying this book state that for those attending from New England a car will leave Boston, which will join other cars leaving New York and Philadelphia, to make a train which will proceed from Buffalo direct to Detroit. The management of the excursion for this section will be under the direction of Messrs. Raymond and Whitcomb, who managed the California trip. The list of papers, titles of which are given, indicate that there will be at least the usual interest in the formal proceedings of the society, and among the other attractions to be provided will be excursions by boat and otherwise to the various points of interest in the neighborhood of Detroit. Meetings will be held in the Y. M. C. A. Hall, and at 8.30 P. M. Wednesday there will be a reception tendered the society at the house of the Detroit Club. On Thursday afternoon there will be an excursion by steamer to Lake St. Clair and St. Clair River. A light lunch will be served on board the boat, and there will be a fish supper at the St. Clair Flats; the party returning to the city at 8 P. M. On Friday afternoon there will be an inspection of the works of the Public Lighting Commission.

The Mason Regulator Company have moved into a new office, at No. 6 Oliver street, Boston, in the center of the machinery district. Mr. Walter G. Chase, who has been the active manager and treasurer since the company commenced business, has retired from the management.

NEW CATALOGS.

We have received from the American Boiler Co., Chicago, Ill., a finely gotten up catalog illustrating and describing a large variety of boilers, designed especially for heating purposes, both for private houses, and on a larger scale for public buildings. The catalog contains a number of fine illustrations of buildings heated by these boilers, and is very complete in respect of illustrations, descriptions and data. It is 5¾"x8¾".

We have received from the Q. & C. Co., 703 Western Union Building, Chicago, Ill., a catalog which is devoted to the illustration and description of all kinds of machinery for cold sawing metals. The machines illustrated include power hack saws and circular sawing machines of various types, and much useful information is given regarding this modern method of cutting up stock. The catalog is embellished with a high art front cover, and is 7" x10".

MANUFACTURES

The Dayville (Conn.) Woolen Co. has been reorganized and will resume operations this fall.

The Sterling Cotton-mill Co., of Franklinton, N. C., has been organized with a capital stock of $50,000. Jno. F. Cannady is president.

The Smith-Rowse Patent Coupler Co. is a newly organized company at Homestead, Pa. A plant for the manufacture of couplers will be located.

The Ohio River Sheet and Tin-plate Company, of Pittsburg, Pa., has been incorporated with a capital of $50,000. The plant will be in operation in July.

The Malleable Iron Fittings Co., of Branford, Conn., have placed the contract for a new foundry building with the Berlin Iron Bridge Co., of East Berlin, Conn.

The new refrigerating plant for the International Cooling Co., Atlantic City, N. J., will be designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn.

The receivers of the Erie Railroad Company have issued an order for the resumption of work at the company's shops at Hornellsville, N. Y., and other points on the road on full time.

The Woonsocket (R. I.) Machine and Press Co. will enlarge its plant this summer. The improvements will include addition to the main building, three stories high 310x35 feet and also new machinery.

Hine & Robertson Co., 61 Cortlandt street, New York, are just fitting up an experimental shop for their indicator department which will insure more prompt delivery of instruments sent back for repairs. This shop is under the supervision of Mr. A. C. Lippincott.

A significant movement with regard to the development of the cotton manufacturing industry in the South is found in the fact that the Kitson Machine Co., Lowell, Mass., and the Whitin Machine Co., Whitinsville, Mass., have decided to establish a general Southern agency for supplying Southern mills and factories with their machines.

The Brown Hoisting and Conveying Machine Co., manufacturers of friction clutches, hoisting engines, ore buckets, etc., and the Elwell-Parker Electric Co. of America, manufacturers of electric generators for railway power plants, lighting, electrolytic work, etc., removed their offices on April 1st from 409 Times Building, to 1112 Carnegie Building, Pittsburg, Pa.

Mr. E. Van Winkle, formerly president and general manager of the E. Van Winkle Gin and Machinery Co., of Atlanta, Ga., has withdrawn from that company and will engage in business for himself under style of E. Van Winkle Gin and Machine Works, at the same place. He will manufacture cotton-mill machinery and oil-mill machinery, and has contracted with the Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for an outfit of lathes, planers, drill presses, etc.

The Leland & Faulconer Mfg. Co., Detroit, Mich., are erecting a steel foundry building, 262 feet by 56 feet, with cupola end 74 feet wide, also annealing and shipping building 35 feet by 95 feet of brick. The foundry above the four-foot brick wall, which comes up to the window sills, will be entirely of steel and glass with the exception of a brick wall around cupolas and core room. It is to be equipped with modern foundry appliances, steam-hydraulic cranes and elevator, Brown & Sharpe core ovens and annealing furnace and cycloidal blower with upright engine on same plate or bed. They will make a high grade of machine castings, making a specialty of very fine nice work, such as sewing machines, typewriter and best grade of machine castings.

Drying by artificially induced currents of air (sometimes heated) is finding many new applications constantly. Among the latest plants put in by the Buffalo Forge Co. being for the American Potato Flour Co., of Saginaw, Mich. This company writes regarding the plant as follows: "We are pleased to say to you, gentlemen, that the heater you put in for us last January has done us more service than any other heater we have ever used, and it is a complete success for us in drying our potatoes so that we could grind and get them into flour. The potato being about 85 per cent. water we have always found it very difficult to get them dry enough before becoming sour until we put in your apparatus."

Machinists' Supplies and Iron.

NEW YORK, June 1, 1895.

Iron—American Pig—We quote standard brands, $12.25 to $12.50 for No. 1; $11.25 to $11.50 for No. 2, and $10.75 to $11.00 for No 2 Plain. Southern brands, $11.75 to $12.25 for No. 1; $11 to $11.25 for No. 2; $10.50 to $10.75 for No. 3; $11 to $11.25 for No. 1 soft; $10.75 to $11 for No. 2 soft; and Foundry No. 4, $10.25 to $10.50.

Antimony—There is no important change in the market. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8¾c; Hallett's 7.10c. to 7¼c., U. S. French Star, 7¼c., and Japanese, 7c to 7¼c.

Lard Oil—Prime City we quote at 52c. to 53c.

Copper—The market is firm and active, and prices have advanced. A large lot of Lake Copper has been sold by first hands at 10¾c., and 10⅝c. to 10¾c. is now quoted. Casting Copper is held at 10c. to 10⅛c.

Lead—The market is firmer, and refiners are holding out for higher prices. A large business has been done at 3.22½c. to 3.25c. New York delivery.

Spelter—Prices are advancing; 3.70c. to 3.75c. is quoted for New York delivery. The demand by consumers is good.

Tin—Prices have declined; spot for round lot was sold at 14 35c. net cash, and 14.50c. store terms. For July and later deliveries 14.50c. is asked.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Young M. E. with exp. wants pos. as designer of steam engs. or gen. mach. Box 185, AM. MACH.

Mech. draftsman, age 23, tech. educated, with 3 years' office & shop exp., wants pos. Box 13, AM. MACH

Wanted—By young mach., work at tool-making under instructions; small pay expected. Box 183, AMERICAN MACHINIST.

Wanted—Position as traveling salesman, by a practical machinist; American; 18 months on road. Box 200, AM. MACHINIST.

Wanted—Position by a steady temperance young man, as layer out in boiler shop. Best of reference. Address H. N. Mc., care of AMERICAN MACHINIST.

A mechanical engineer of 8 years' practical experience on great variety of work, is open for immediate engagement. Box 22, Williamsville, N. Y.

Wanted—A situation as foreman in a jobbing foundry; 20 years' experience; the best of reference. Address P. H. Spaid, Rochester Post-office.

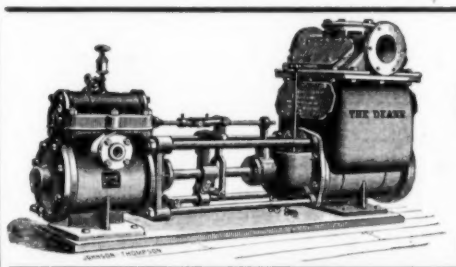
Machine draftsman of experience, skill and ability, wants engagement; would take charge of small drawing-room; is fully comp't. G. R., AM. MACH.

Competent mech'l engineer wants responsible position. 15 years exp. on hoisting mach'y. Steam, water power, and electric mach'y. Best refs. from concerns of highest standing. Box 195, AM. MACH.

Machinists Wanted—Several first-class general machinists can find steady work with good wages at the Fulton Foundry and Machine Works, 21 Furman St., Brooklyn, N. Y.

Wanted—Position as woodwork instructor in trade, technical or M. T. school exp. teacher; also as pattern foreman in electric steam and mechanical work 12 yrs., best refs. Box 10, AM. MACH.

(*Continued on Page* 453.)



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The Steel so generally used now for Machine Shop Tools.
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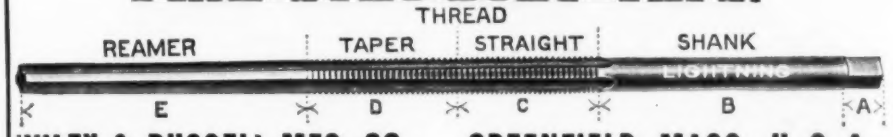

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SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
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THE MECHANICAL ENGINEERS' POCKET BOOK.
A Reference Book of Rules, Tables, Data and Formulæ, for the use of Engineers, Mechanics and Students.
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Consulting Engineer, Member American Society Mechanical Engineers and American Institute Mining Engineers.
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Ready Made Iron Gears.
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Gears Made to Order.
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1895 Gear Book, Free.
Treatise on Gears, $1.00.
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Cut Theoretically Correct.
Special facilities for cutting worm wheels.
HUGO BILGRAM,
MACHINIST,
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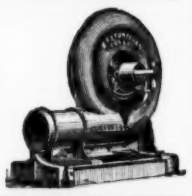

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The price at which we are selling (not offering, but selling) our lathes and tools is causing surprise. We are prepared to turn out high-grade tools at very low prices; our profits are small, but we are satisfied, and we give satisfaction to our customers, so there's both profit and glory.
Our catalogue will tell you all about our lathes, planers, shapers, etc. Prices quoted on application.
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ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
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Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
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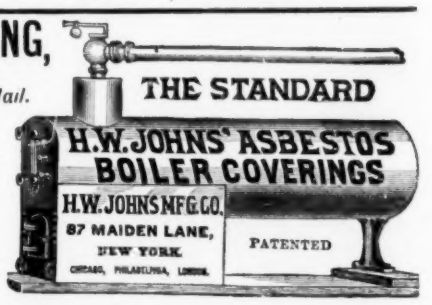

✻WANTED✻

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Twist Drills—A practical man who is thoroughly experienced in the manufacture of twist drills can secure a good position; give full particulars, age, etc. Drills, care of AMERICAN MACHINIST.

Molders Wanted—A number of first-class men on light bench, floor and press work; can find steady work with good pay at the Fulton Foundry and Machine Works, 21 Furman St., Brooklyn, N. Y.

Wanted foremanship by one who is well up in locomotive foundry practice; have had eight years' experience as foreman; understands thoroughly iron, brass, dry sand and green sand work, can give best of refs. BOX 14, AMERICAN MACHINIST.

Wanted—Superintendent and mechanical engineer; one thoroughly capable in designing Corliss engines of all kinds and the handling of 300 men; an experienced man only. Address, with references, A. B. C., care of AMERICAN MACHINIST.

Competent machinist and tool maker, 36, German native, who has large experience with auto. and fine mach. as well as on general machinery, with best of ref., des. pos. as foreman in N.Y. or Jersey City; 5 yrs. as foreman in pres. pos. G. M. D., AM. MACH.

Wanted—A first-class all-round machinist capable of meeting the most exacting modern requirements; permanent position for right man; opportunity for advancement. Apply, with references, Buchel Mach. Works, 827 Conti St., New Orleans, La.

A first-class foundry foreman and general molder with extensive experience in handling work and men, mixing and melting metals and general foundry knowledge, wishes situation; strictly temperate, with highest testimonials as to character, executive ability, etc.; American; aged 38. Practical, AM. MACH

Wanted in a western city in a well-organized modern machine tool shop, building high-grade work only, a leading vise hand, fully capable to direct a half dozen other vise hands, and to work along with them. Must be a hustler, and able to produce the best work at a competitive cost. Address, stating age, married or single, wages wanted, and references, X. Y. Z., AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—Second-hand planer, also lathes. Gage Machine Works, Waterford, N. Y.

Machine shop wanted; will take interest if desir'e; can furnish abund'e of work. Box 12, AM. MACH.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

Wanted—A manufacturing firm to build and sell new style bicycle from the working draft, which is thorough; it is calculated to weigh 13 pounds. BOX 11, AMERICAN MACHINIST.

Very valuable patent for sale, of March 26, 1895, No. 536,306, covering single sheared and gang ploughs; price reasonable. Address M. Weber, Room 27, Wood Building, New York.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

For Sale or Trade—Complete plant, foundry, machine shop, tools and stock (established 10 yrs. and paid good dividends) in one of the best agricultural States of the West, making a specialty of grain elevator and mill mach'y, and in close proximity to mining districts. Good railroad facilities. Address W. 2, care AMERICAN MACHINIST.

A permanent situa'n in Lancashire (Eng.) is open for a manager in a small toolmaking establishm't employing 150 men; experience in the systematic management of work and men required. Reference given to applicant conversant with mass product'n upon the American system. Write, stating salary required, to T. T., Box P., 52,352 Smith's Advertising Agency, 132 Fleet street, London, E. C. England.

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Any Style or Graduation.
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NONE BETTER.
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5	1½	.80	14	4	2.10
6	1¾	.95	15	4½	2.75
7	1¾	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
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1 Set to 2 in.		7.80	Full Set.		31.10

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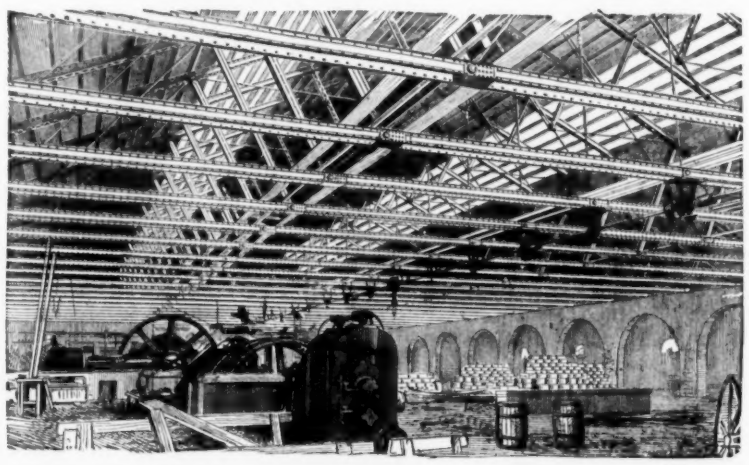
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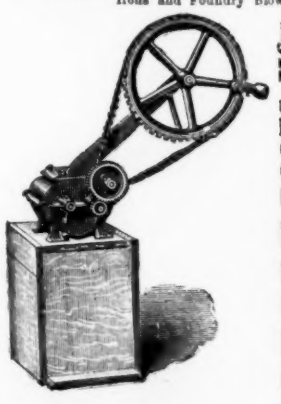
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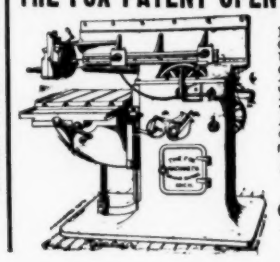
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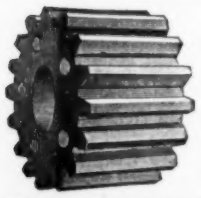

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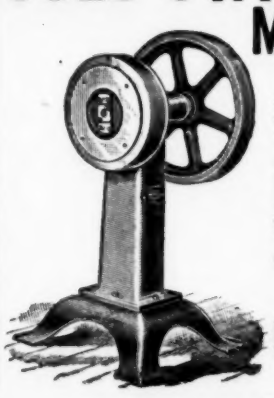

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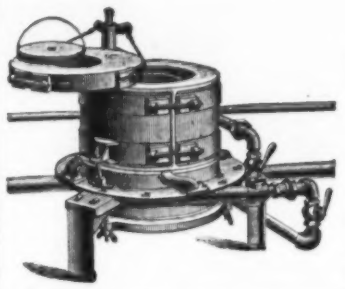

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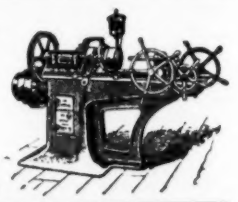

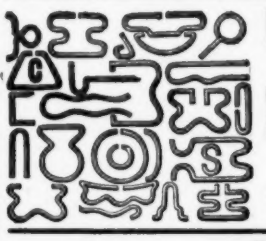

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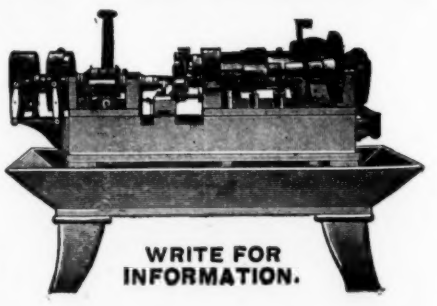

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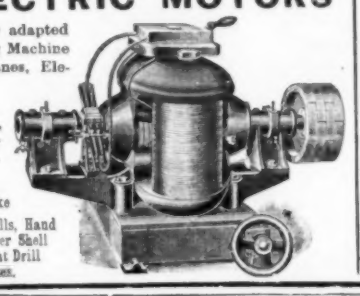

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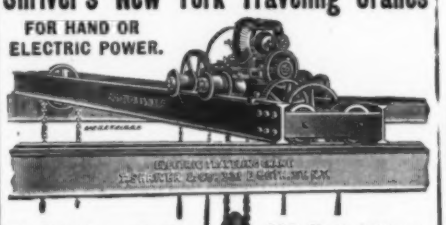

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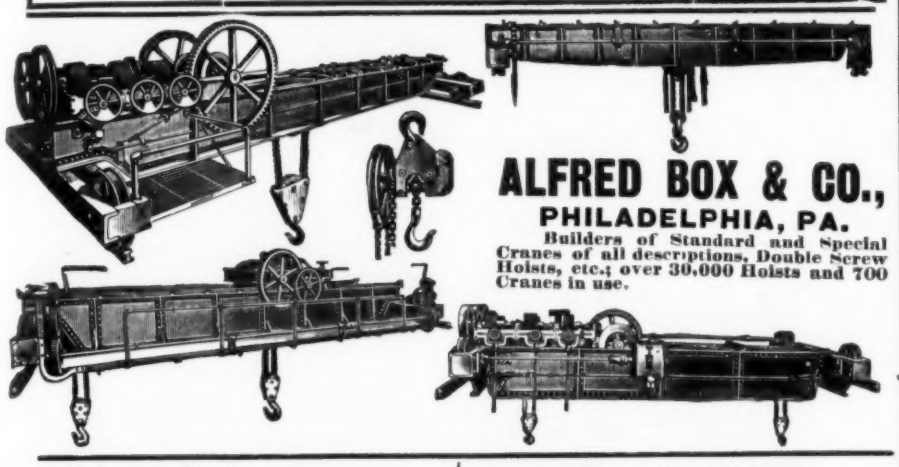

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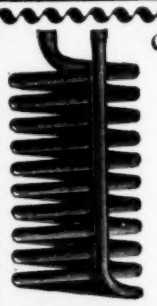

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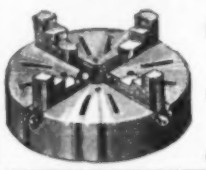

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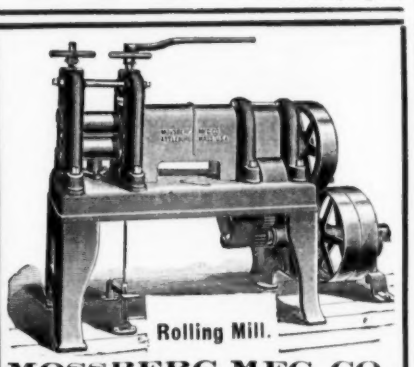

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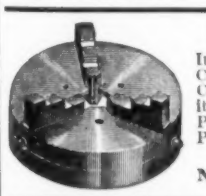

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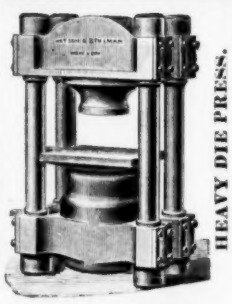

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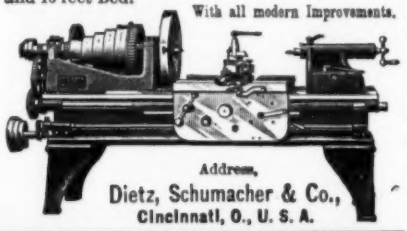

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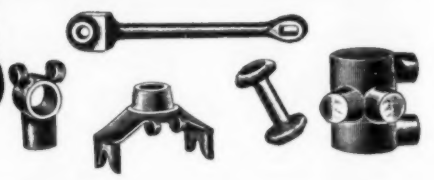

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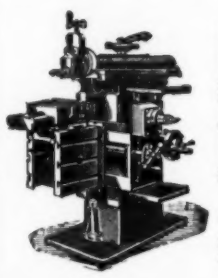

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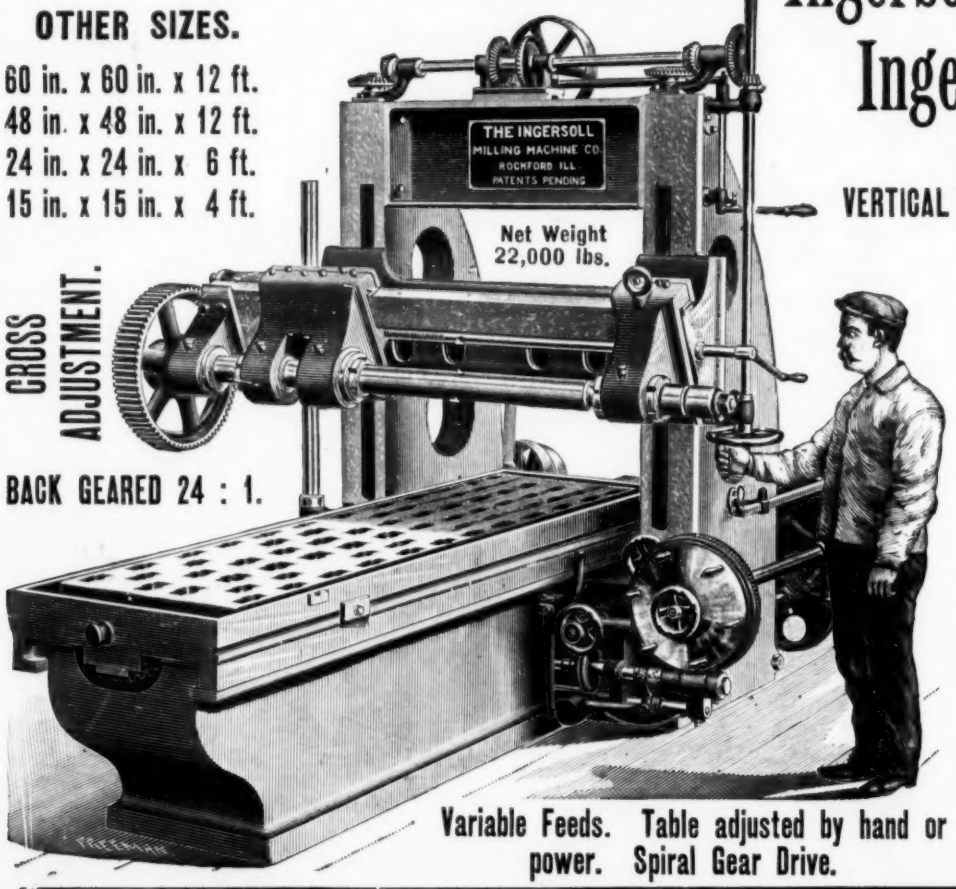

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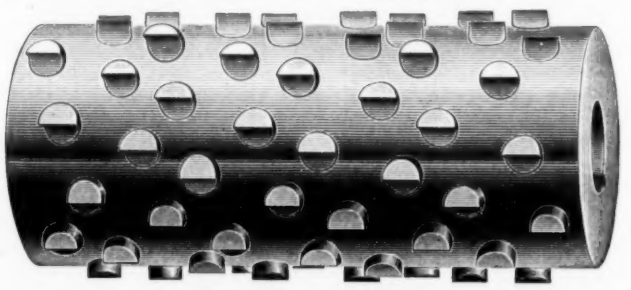

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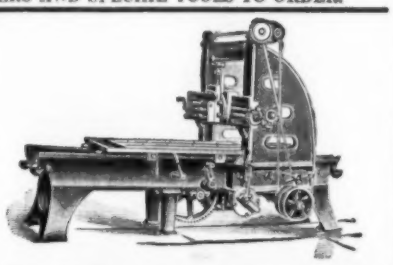

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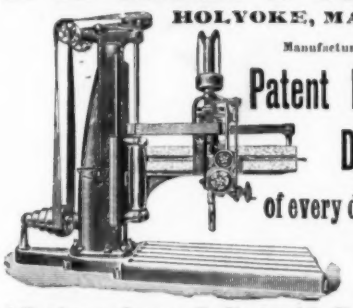

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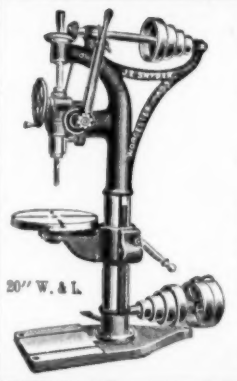

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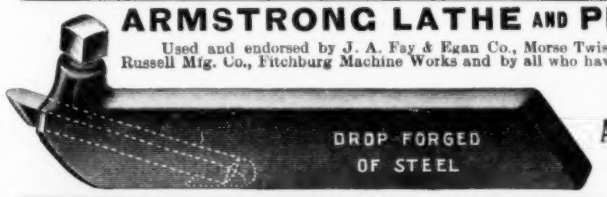

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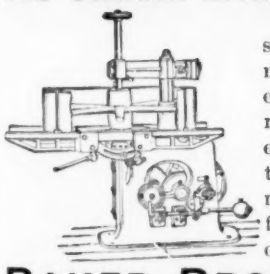

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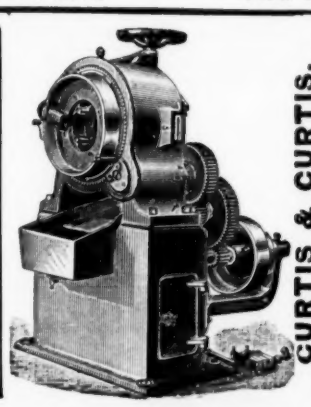

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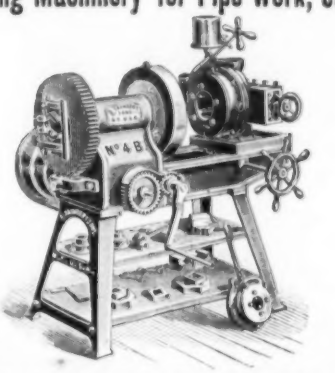

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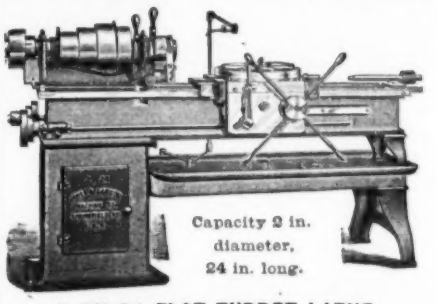

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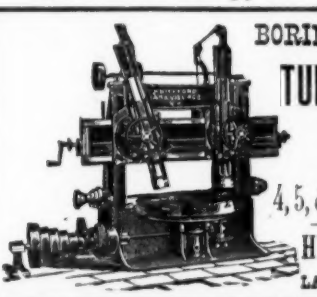

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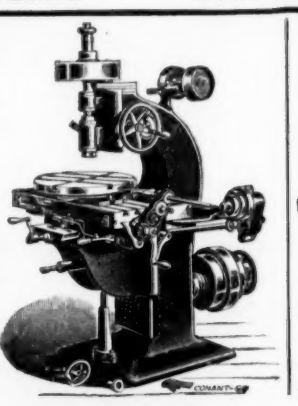

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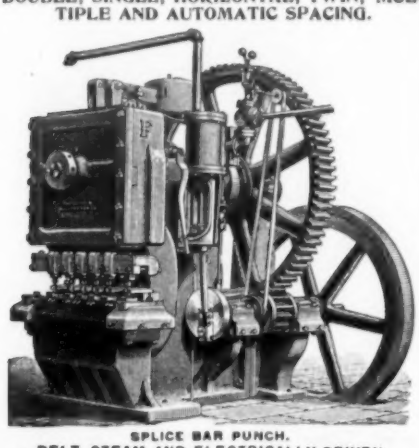

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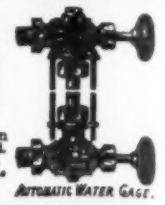

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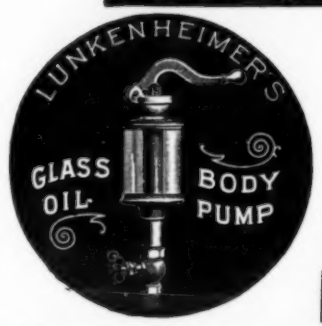

The "Lunkenheimer" Glass Body Oil Pump
is easily filled and operated, and is intended to be used on Stationary Engines. No large Engine should be without a cup of this kind as an auxiliary to the Sight-Feed Lubricator. **Simple, Reliable, Ornamental.** This pump will be found very convenient in case of an accident to the Sight-Feed Lubricator, or to be used before starting the Engine. Our list of users would convince you that our Oil Pump stands unrivaled, and is **always specified** wherever the **best** is wanted. Nothing so convincing as a trial. Our new Catalogue will post you on "up to date" specialties. Gratis upon request.
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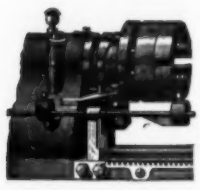
EUROPEAN STORE THE LUNKEN VALVE CO. 85 CANNON ST. LONDON E.C.

DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.
MANUFACTURERS OF THE
ADAMS
Automatic Bolt-Threading and Nut-Tapping Machine,
Made in all Sizes to Cut from 1-4" to 6".



The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list.
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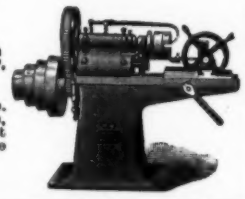

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and how do you do it. Did test to them? Are you ac-
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If not, send for Catalogue you full particulars, but useful to every mechanic,
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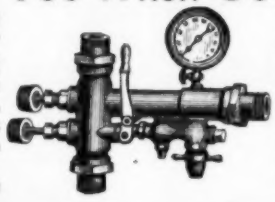

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Good profits.
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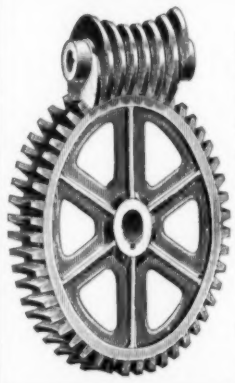
Albro Worm and Worm Gear



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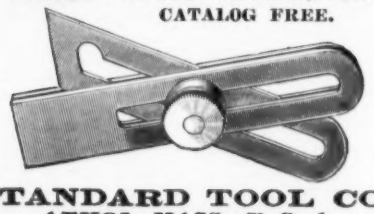

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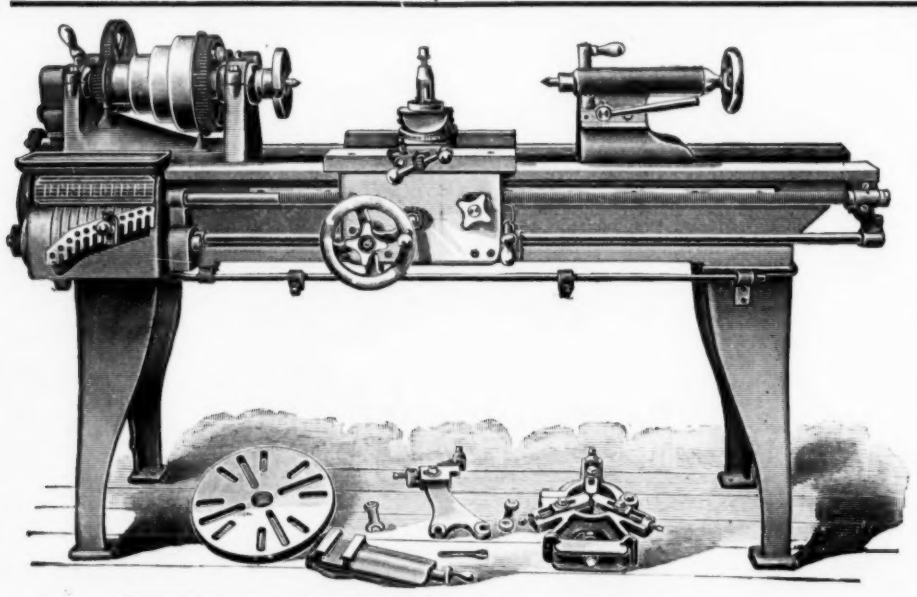

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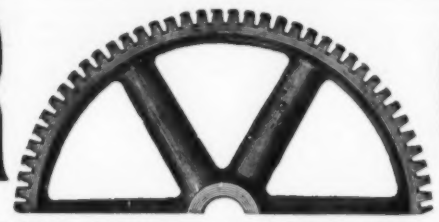
GEARS  CUTTING

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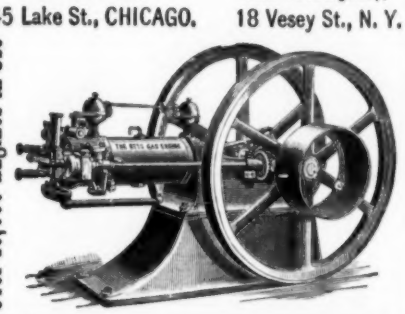

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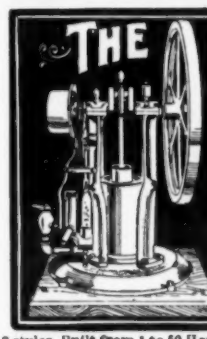
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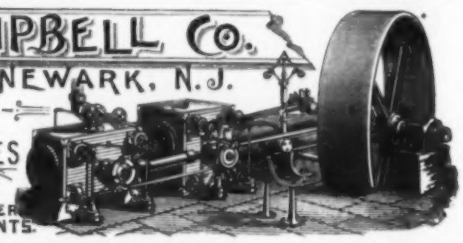

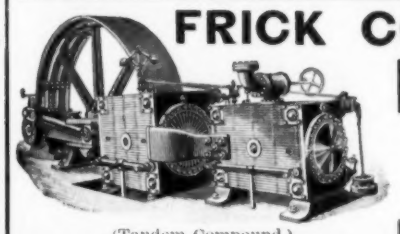
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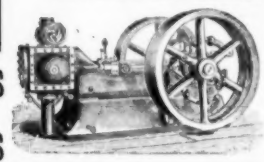
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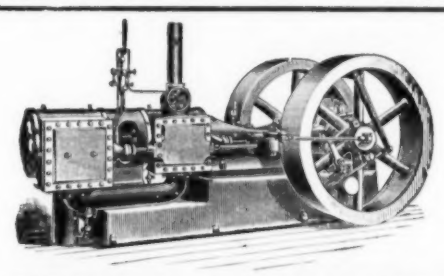
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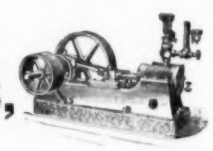
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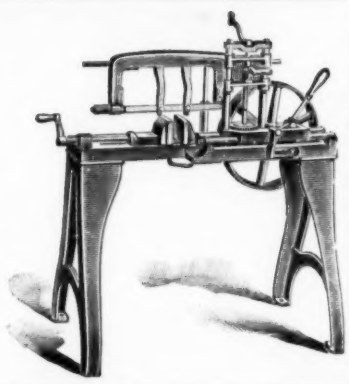

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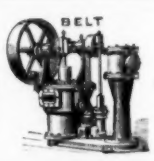
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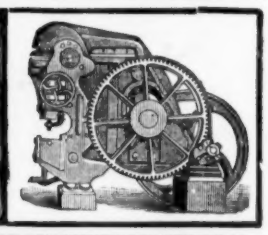

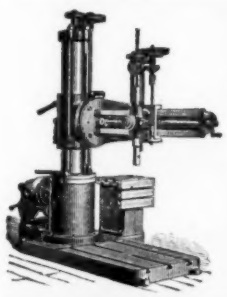
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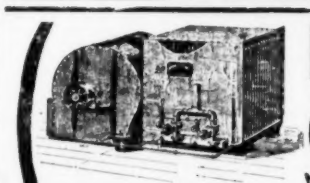
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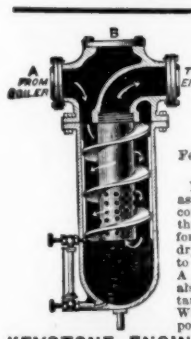
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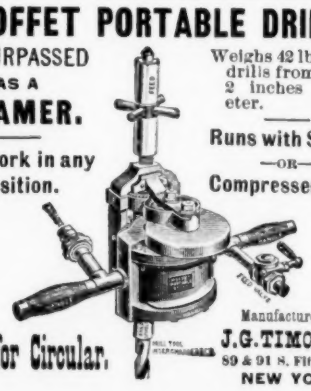
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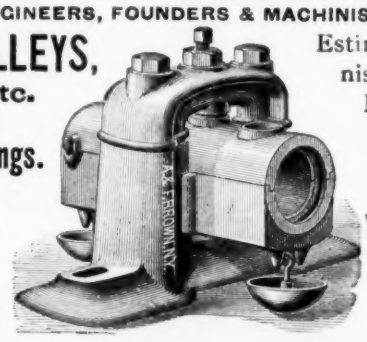
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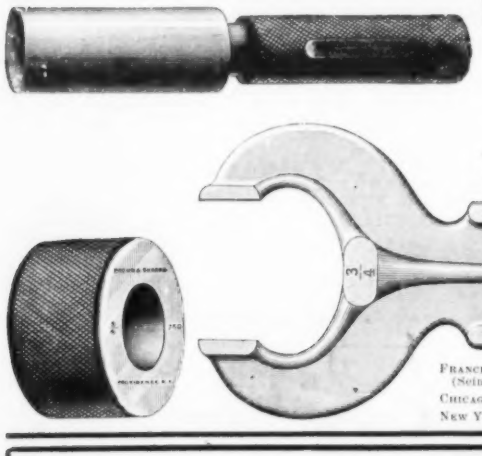

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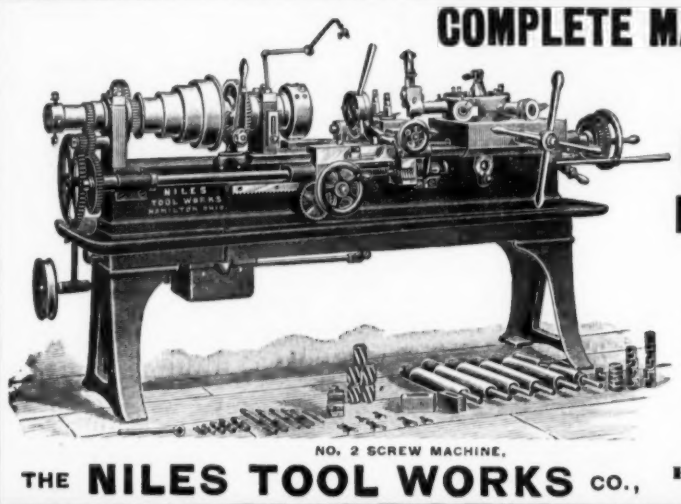

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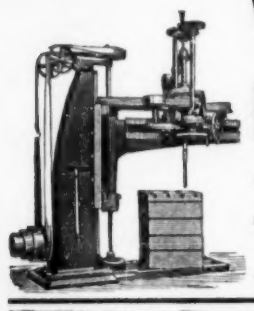

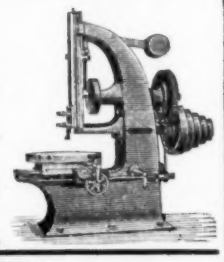

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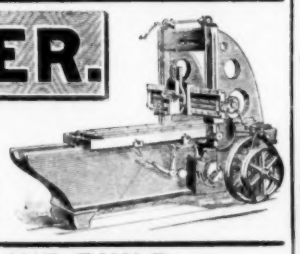

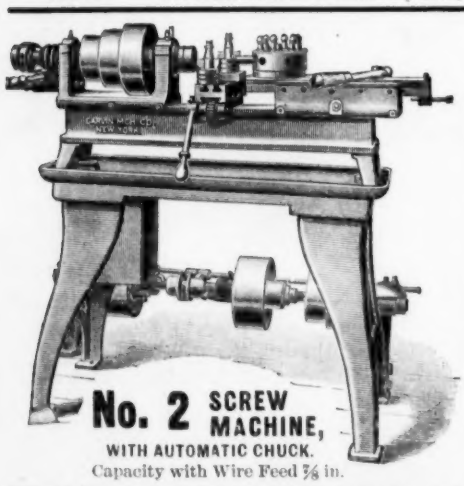

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WITH OR WITHOUT
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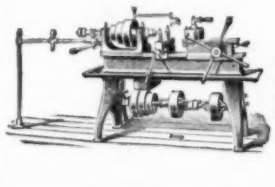

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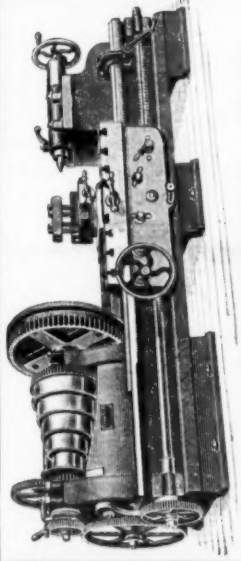

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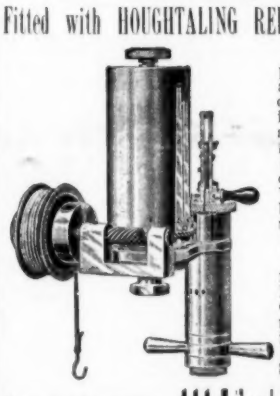

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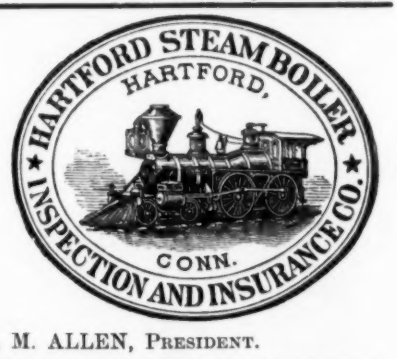

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